The Engineer

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THE ENGINEER

Established 1856

No. 5353 **AUGUST 29, 1958** VOL. 206

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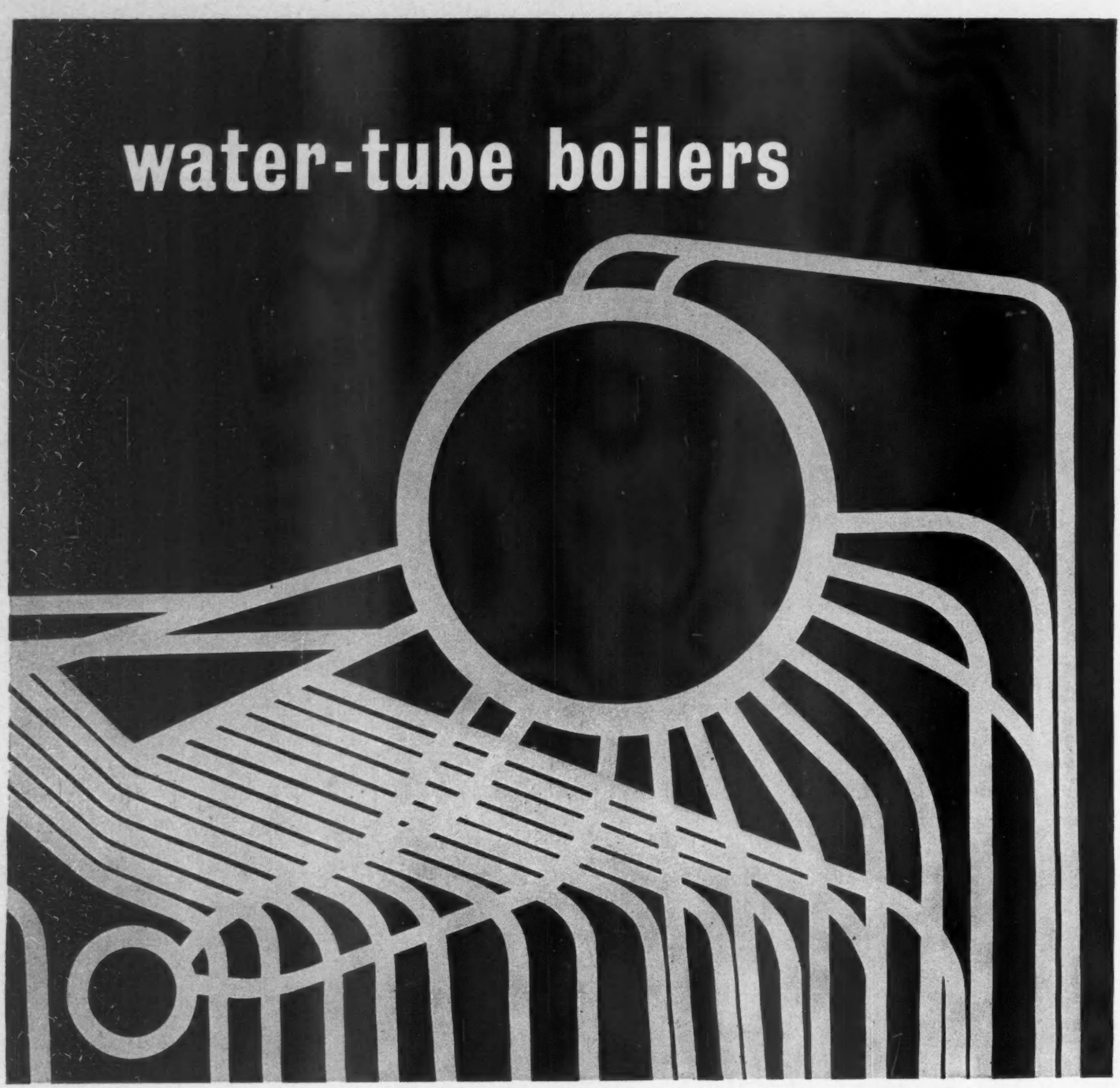
water-tube boilers



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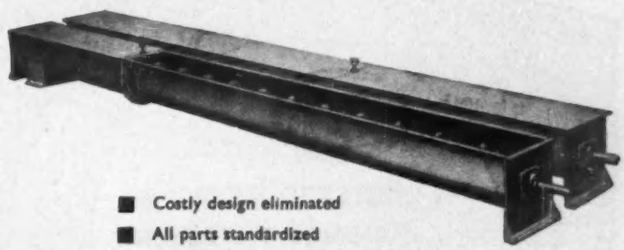

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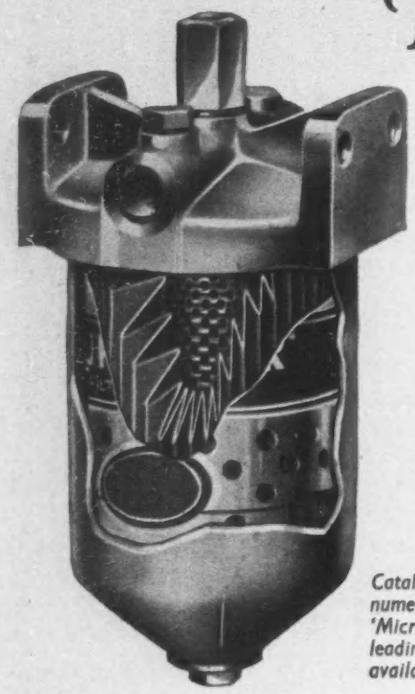

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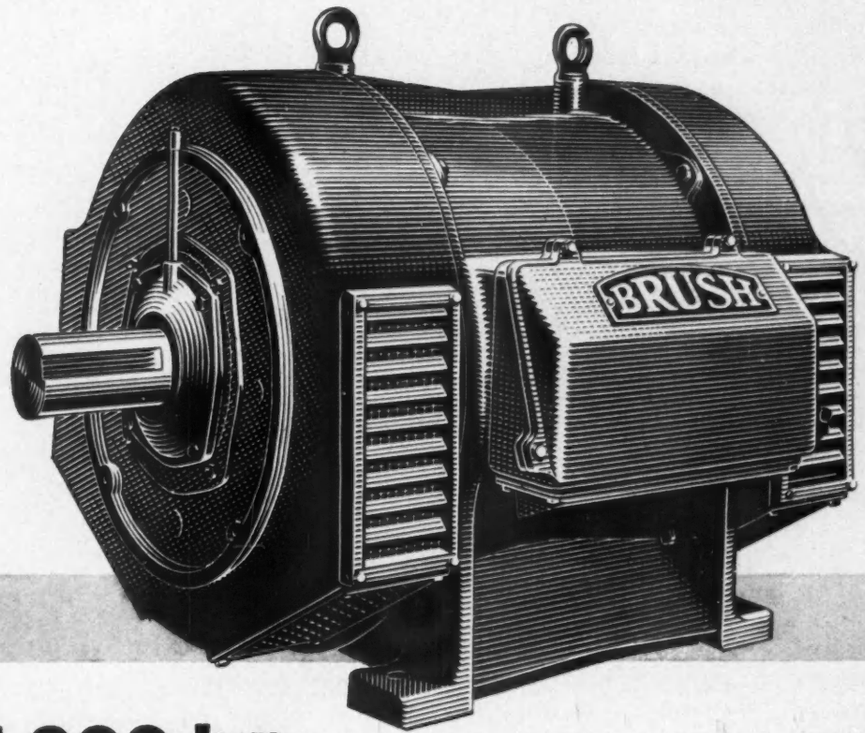

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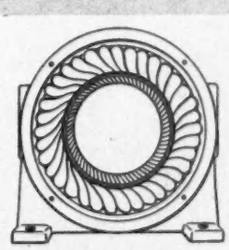

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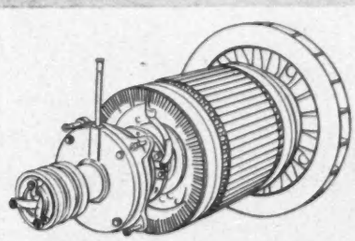

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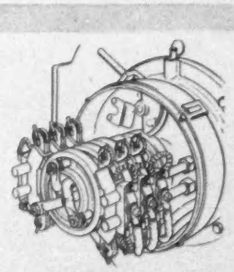

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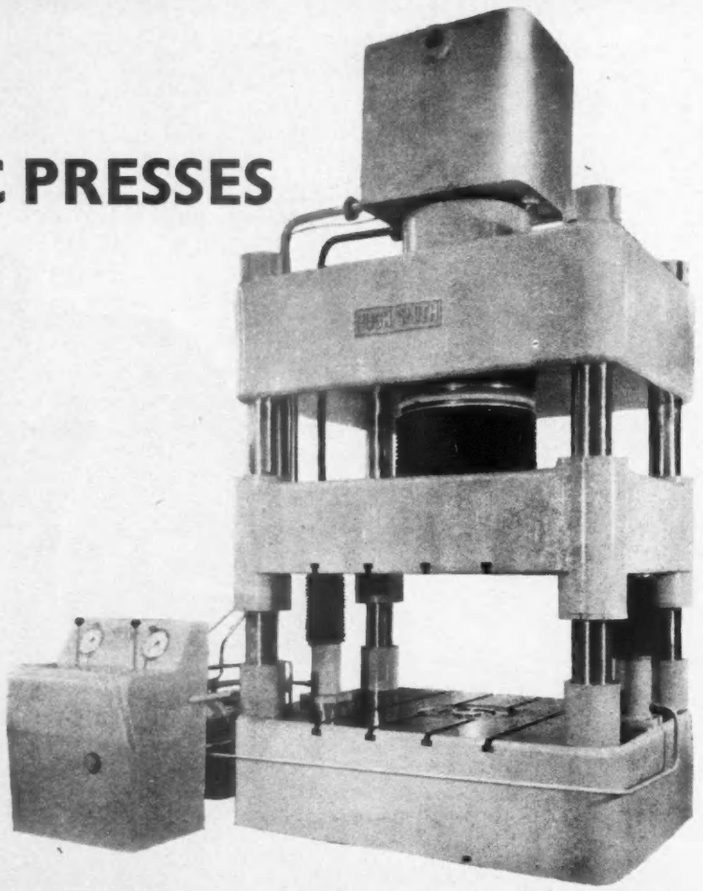

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Finger-tip control of heavy electrical plant

by

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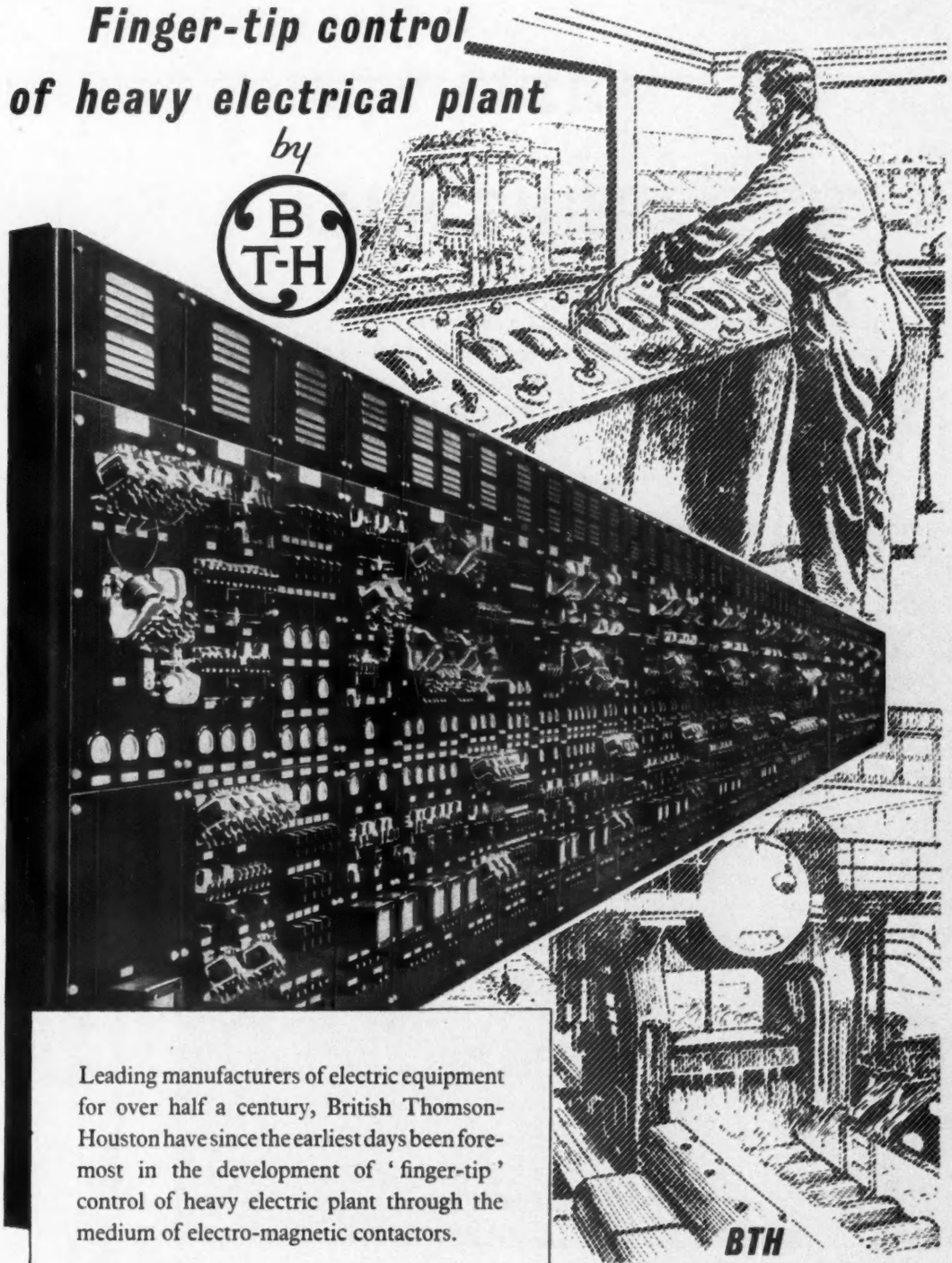

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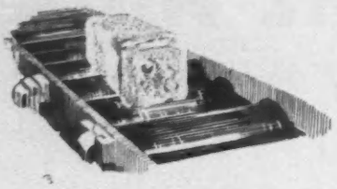

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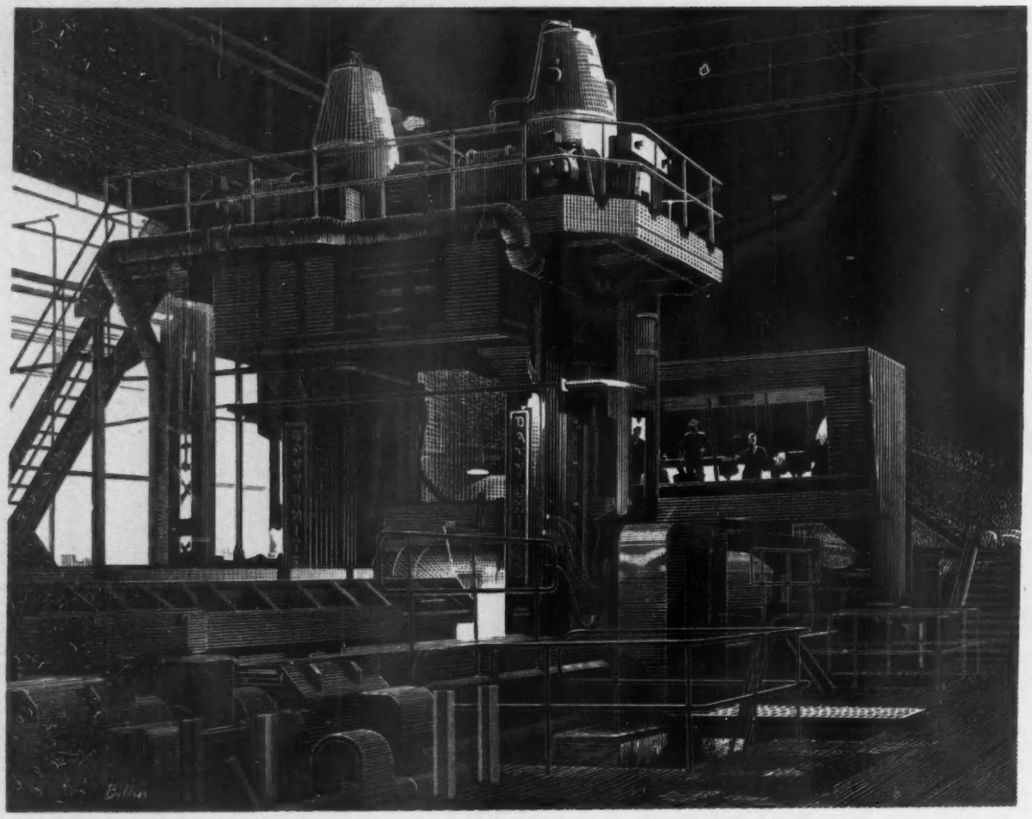

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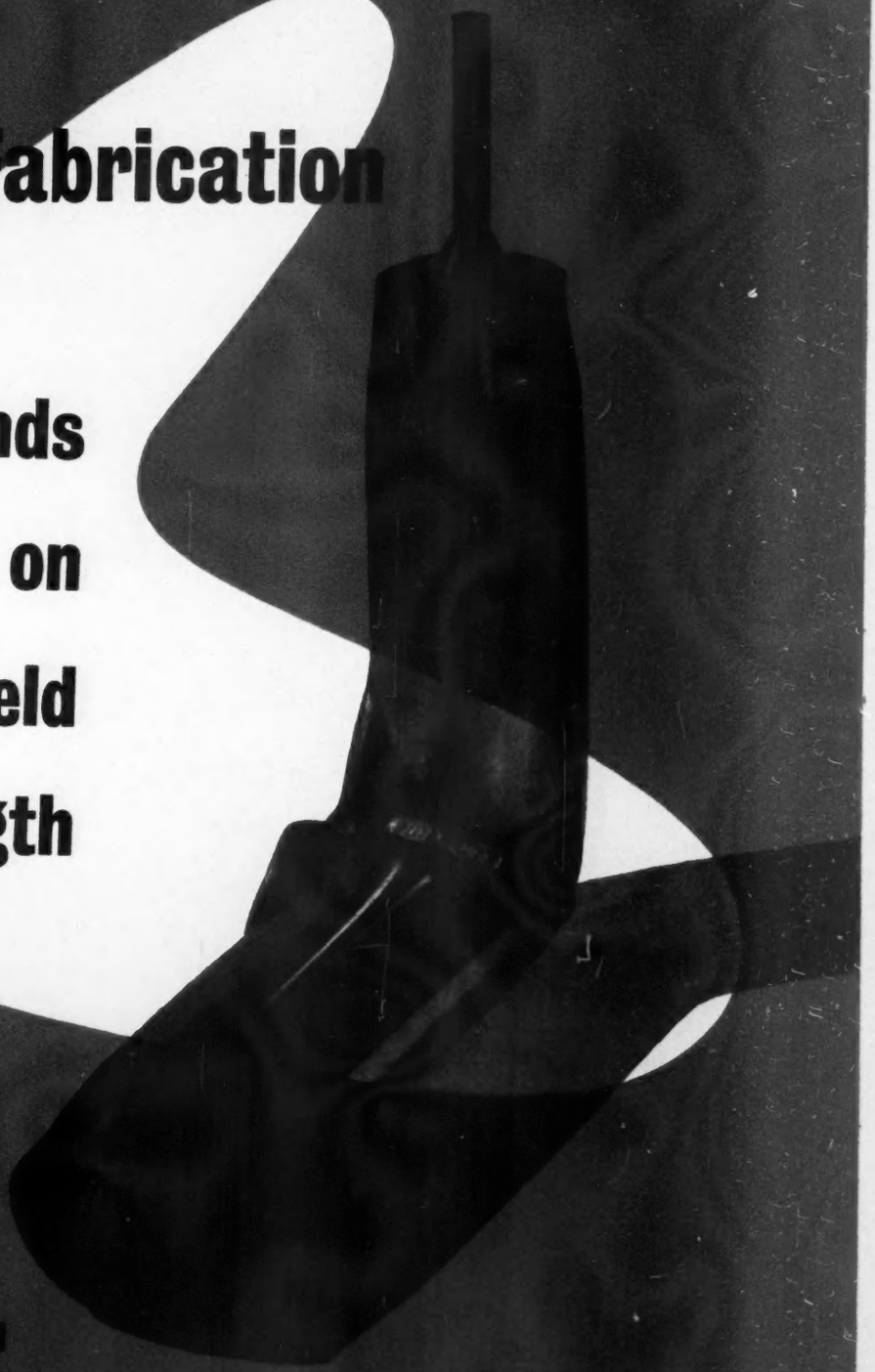

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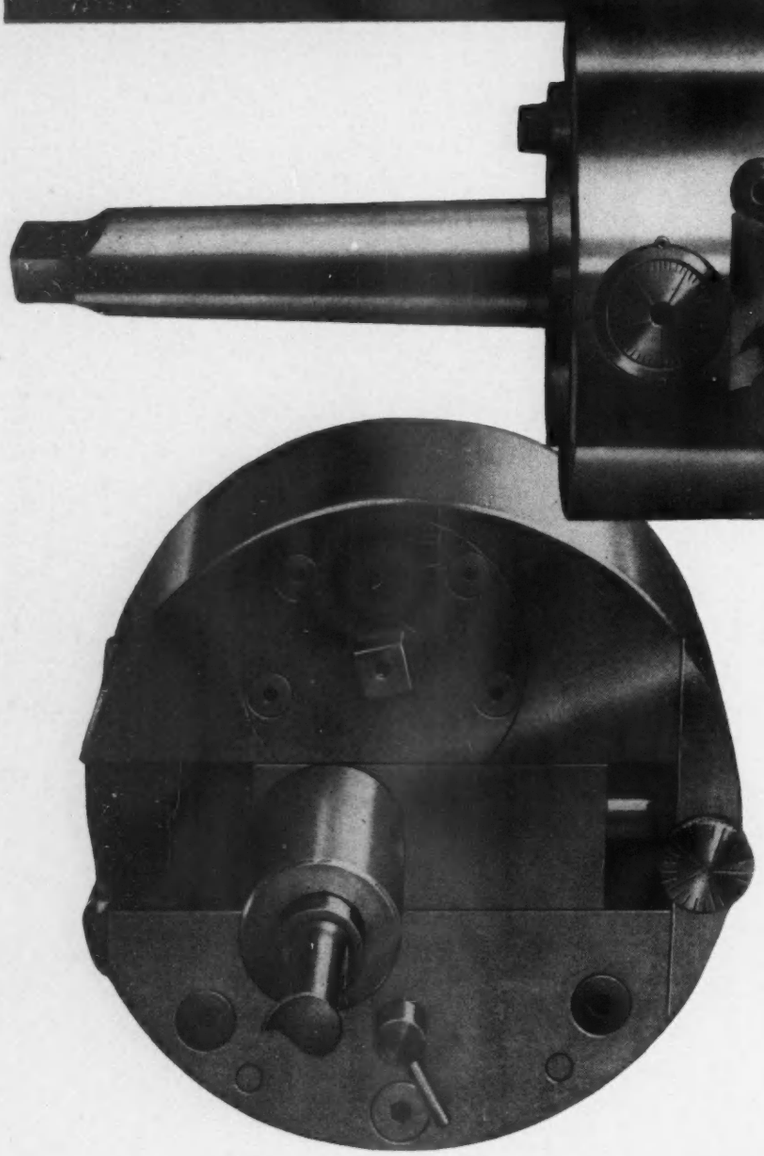

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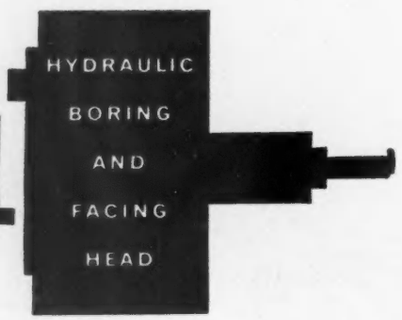

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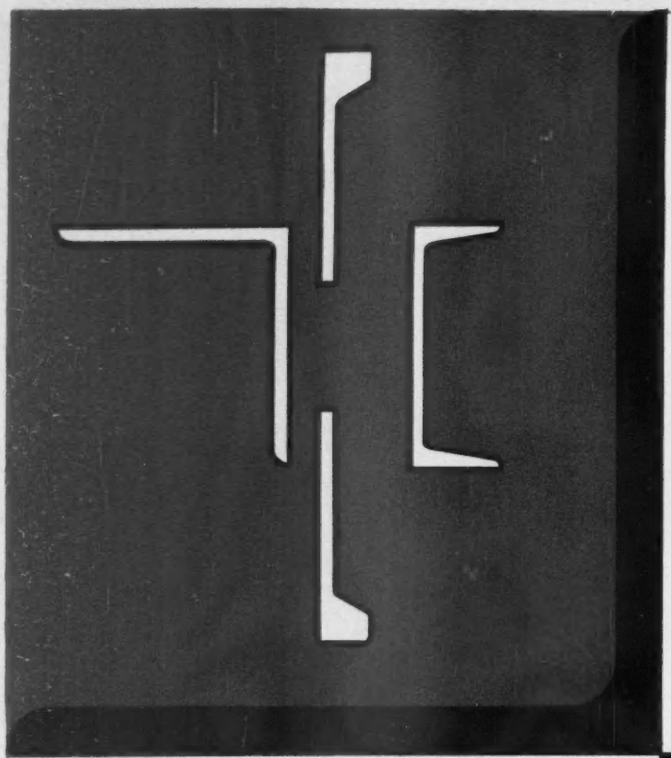

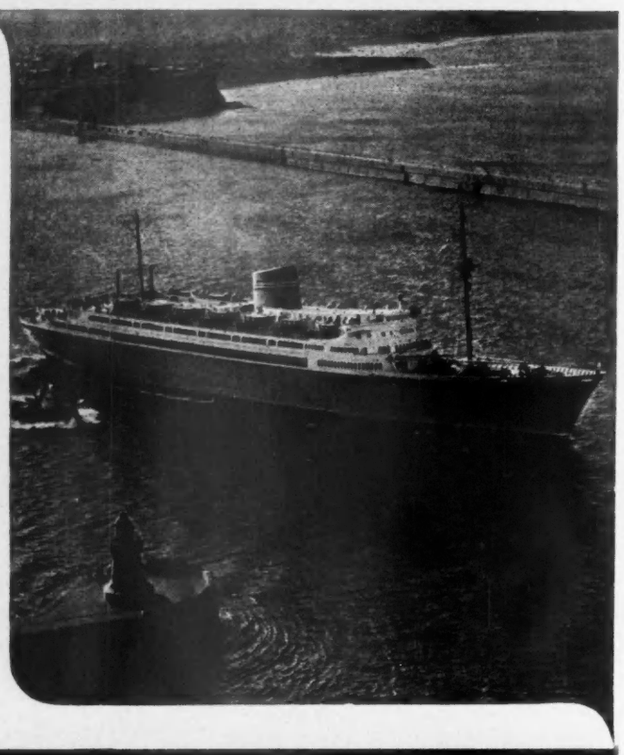

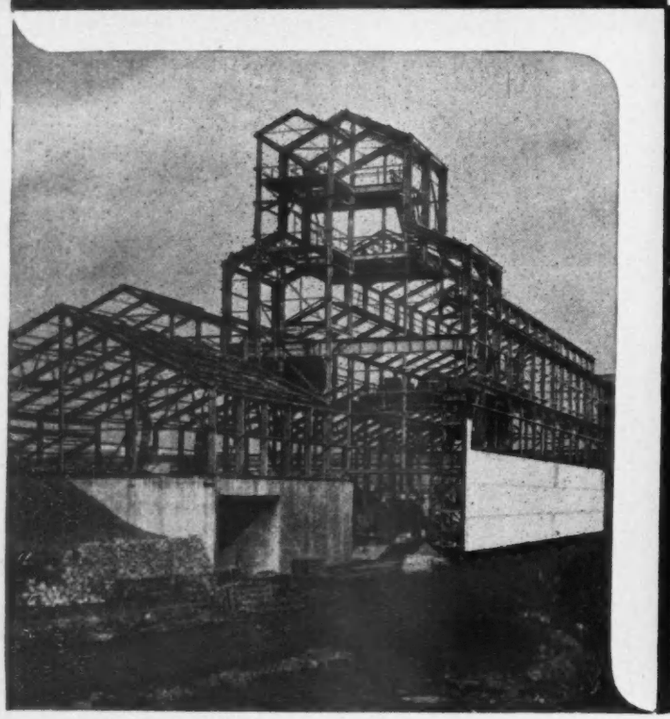

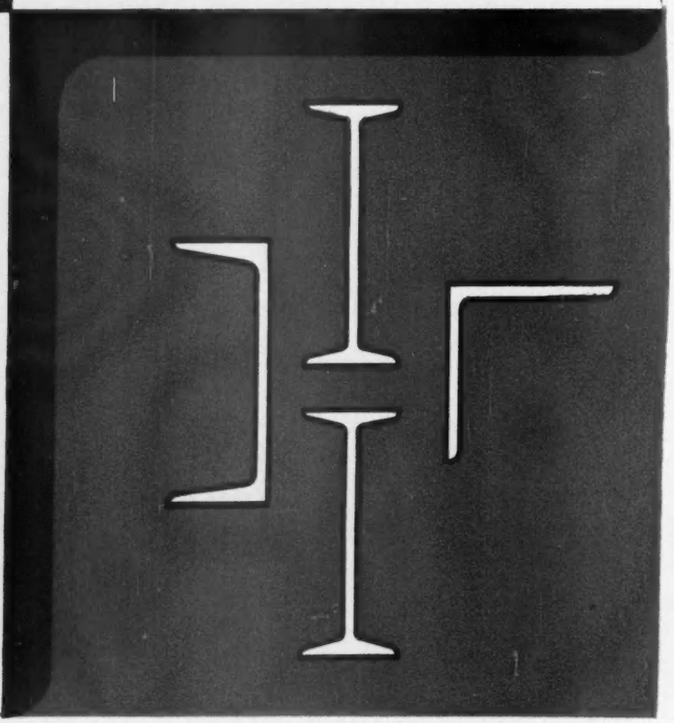

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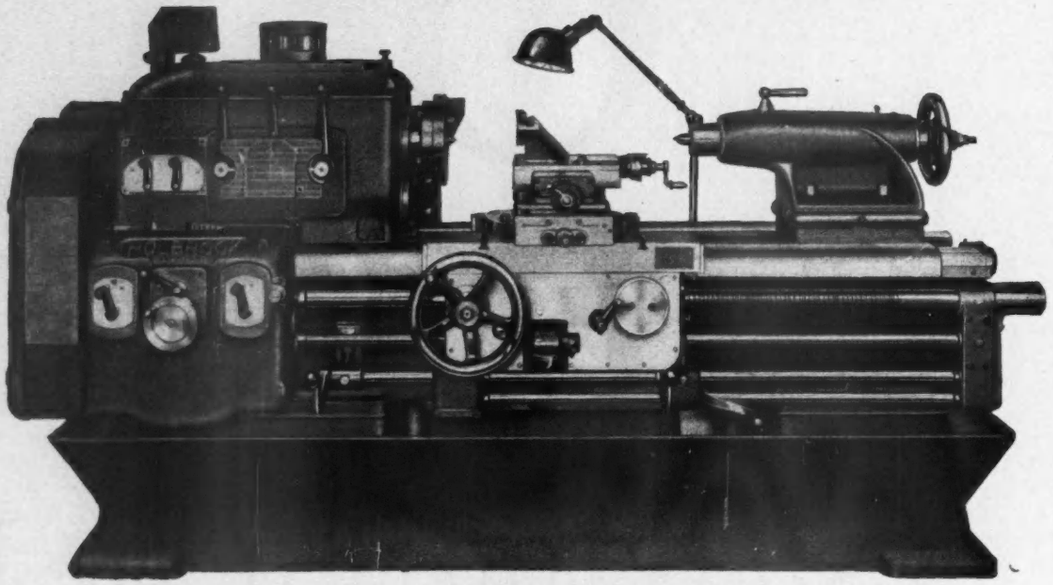

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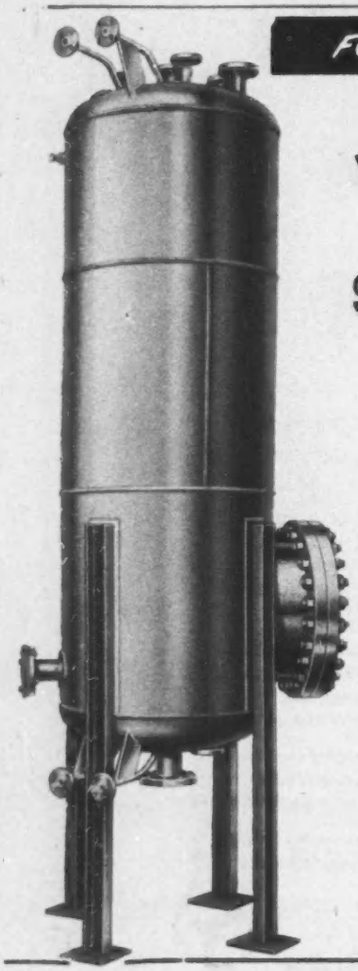

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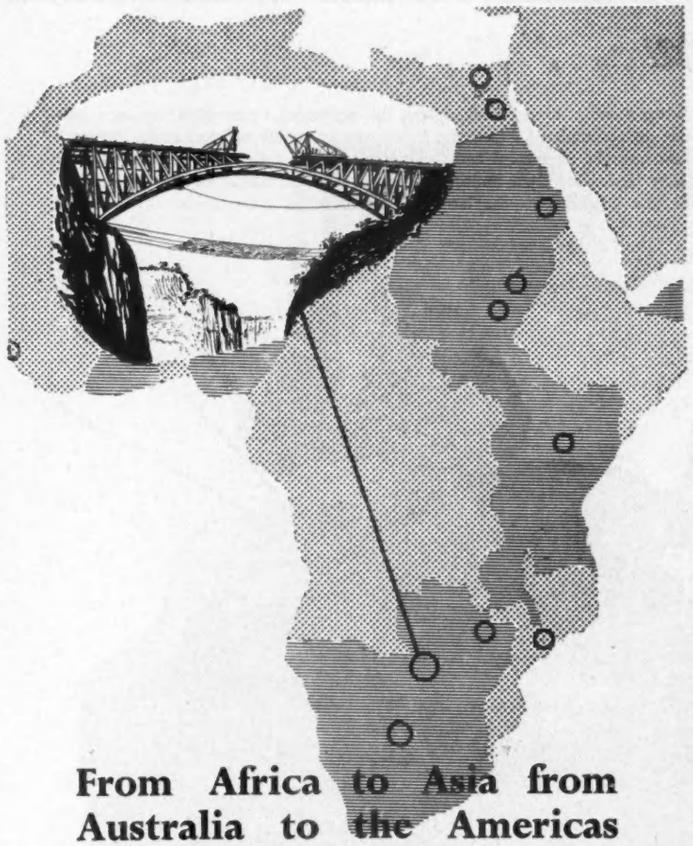

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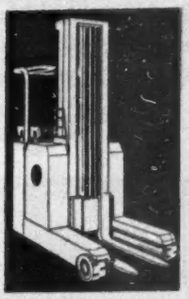

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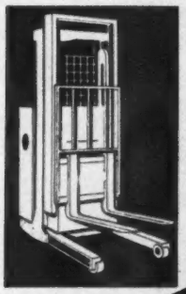

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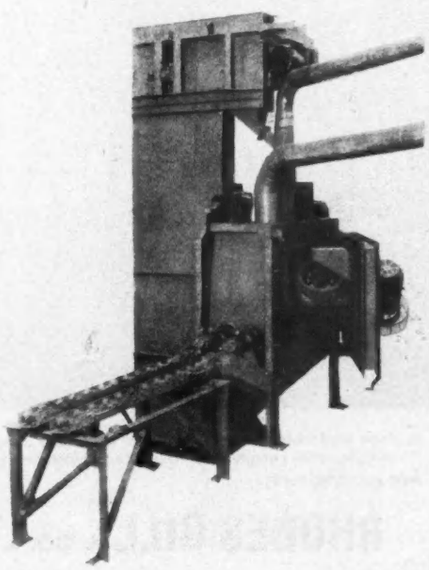

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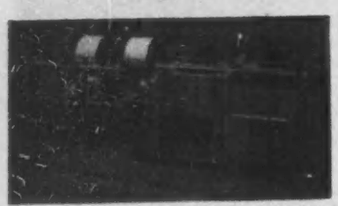

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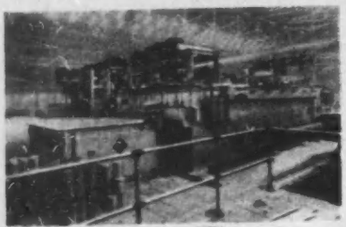

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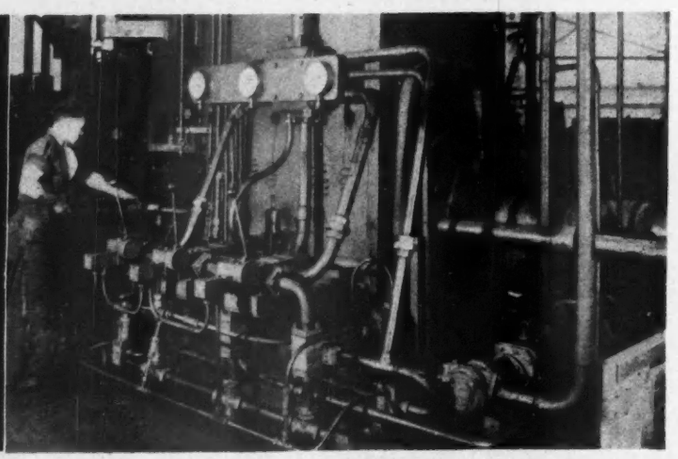

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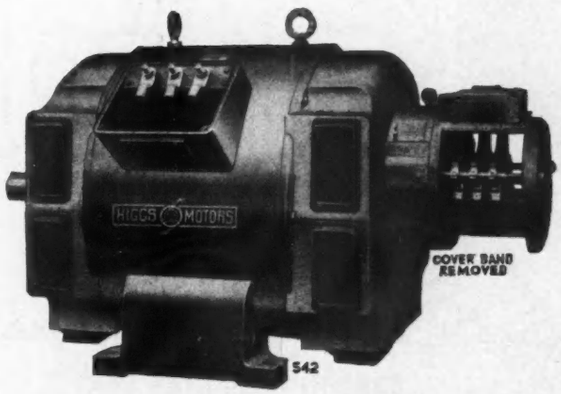

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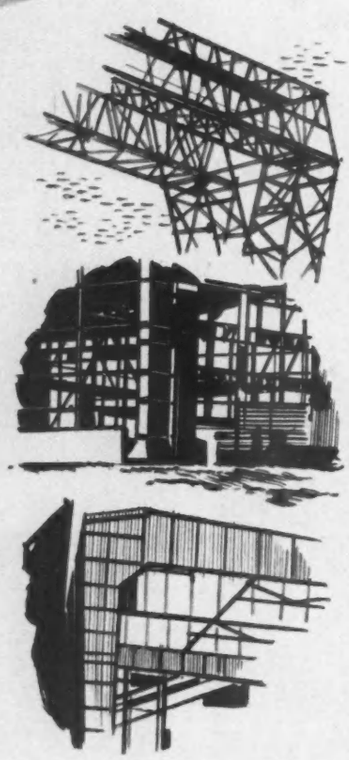

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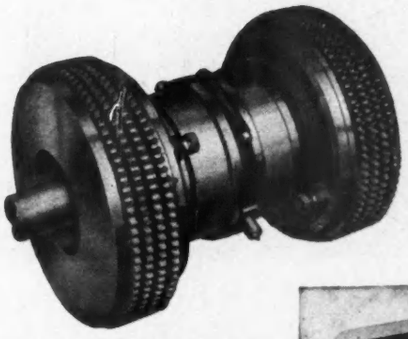

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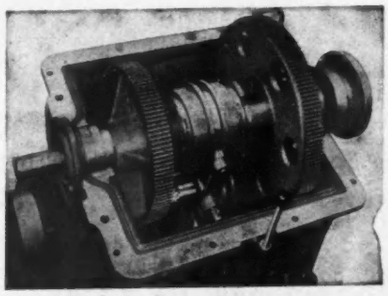

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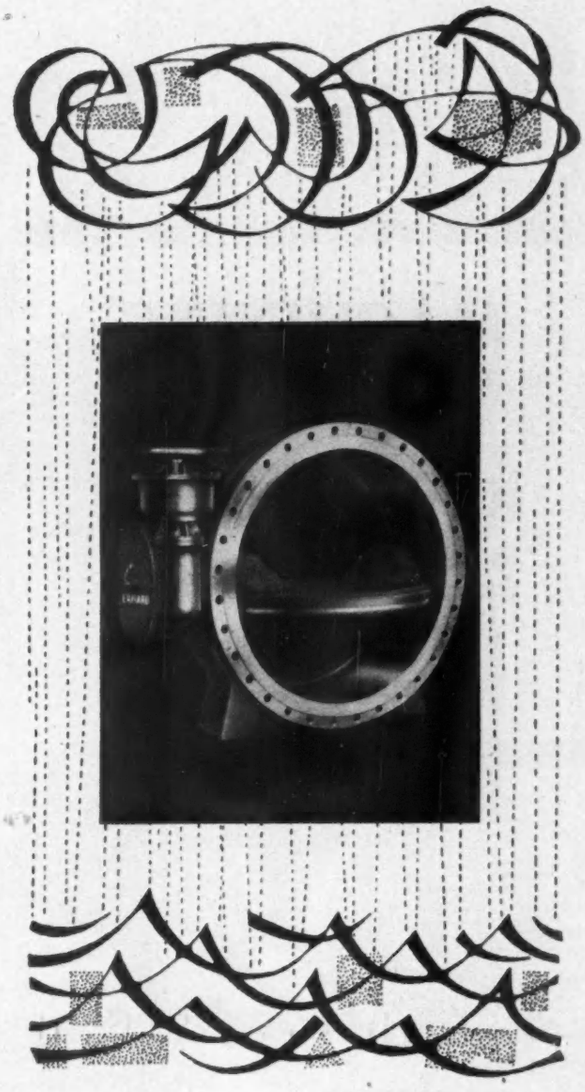

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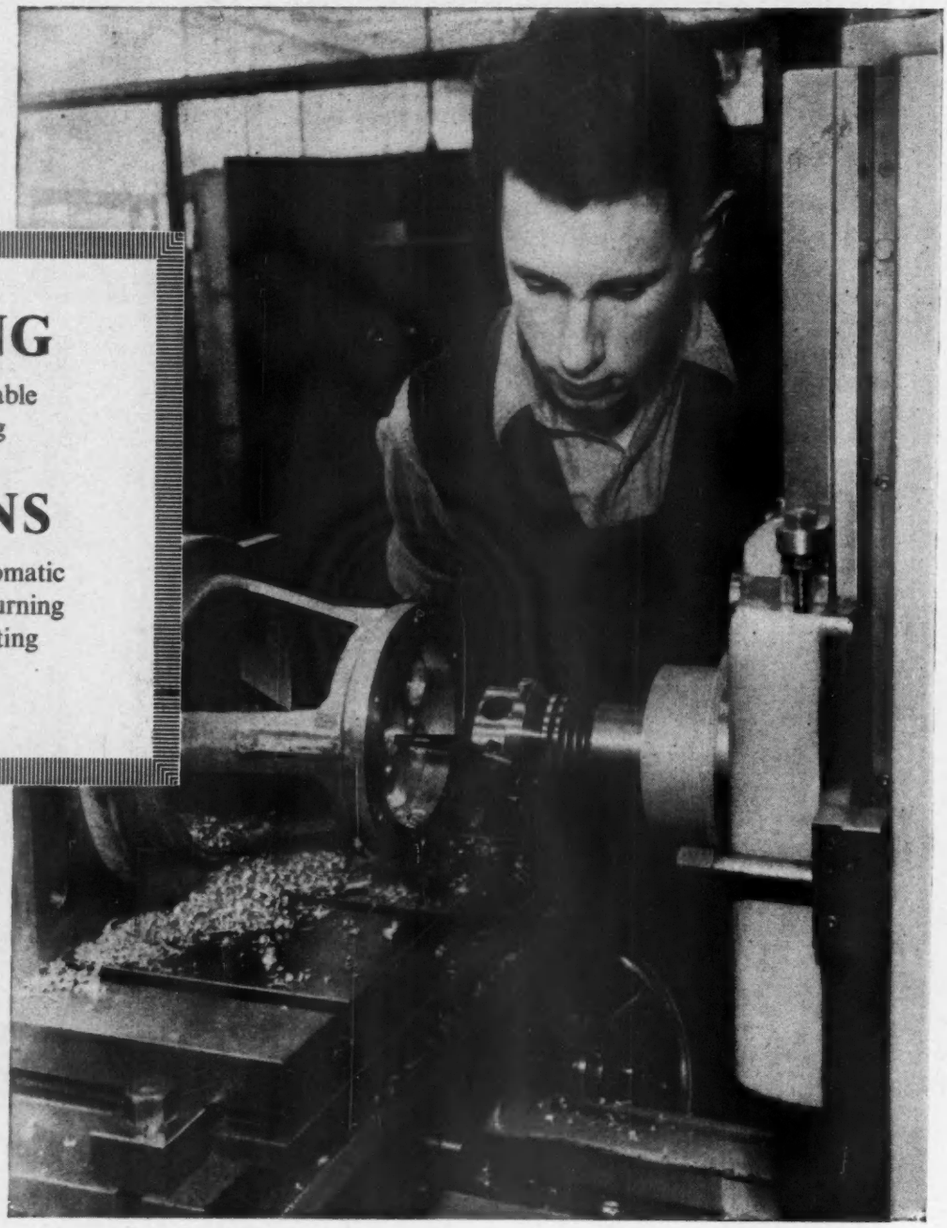

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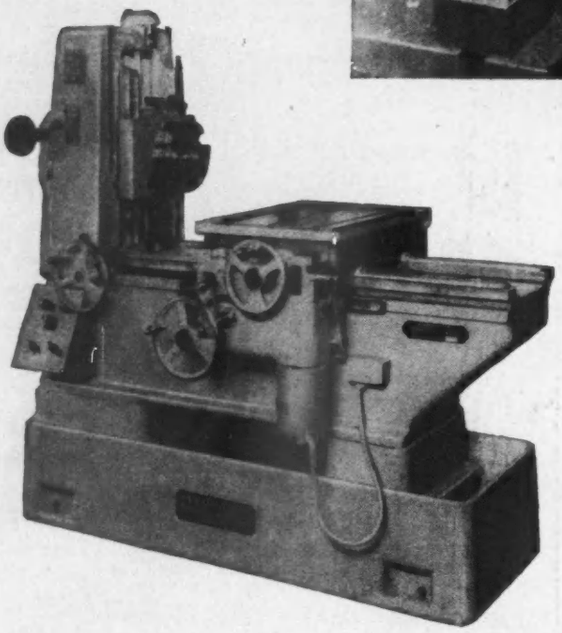

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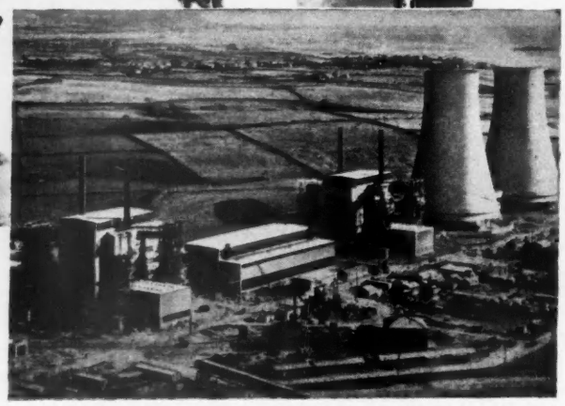

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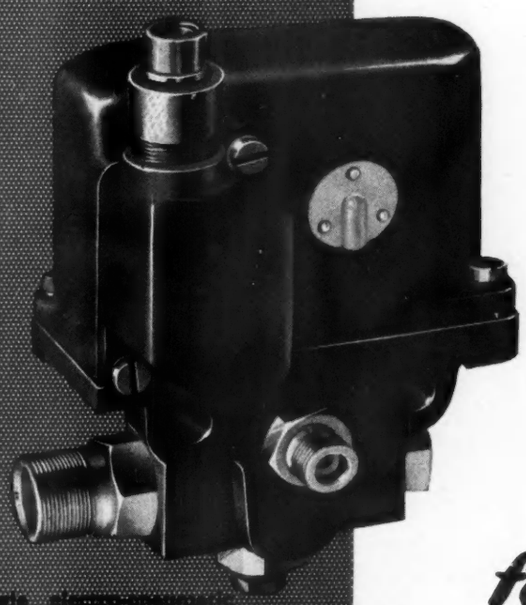
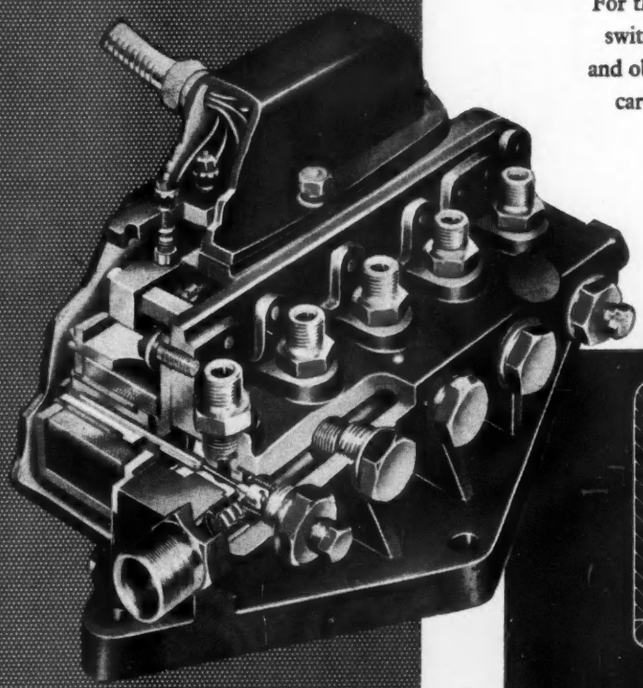


Single electro-pneumatic valve block. (Weight 2½ lb)



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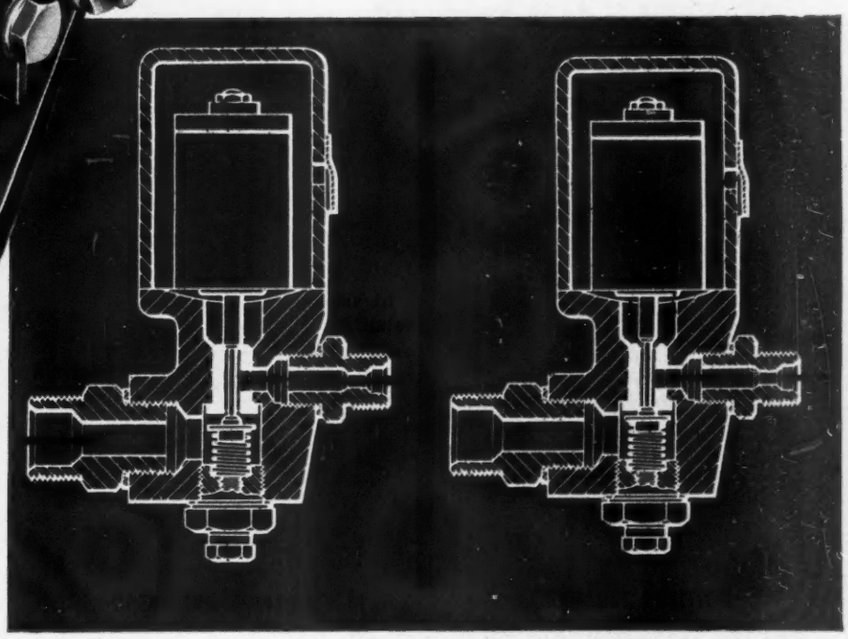

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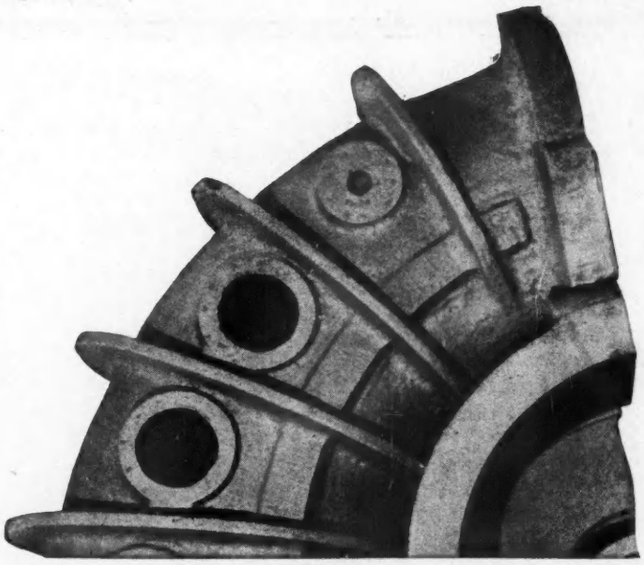
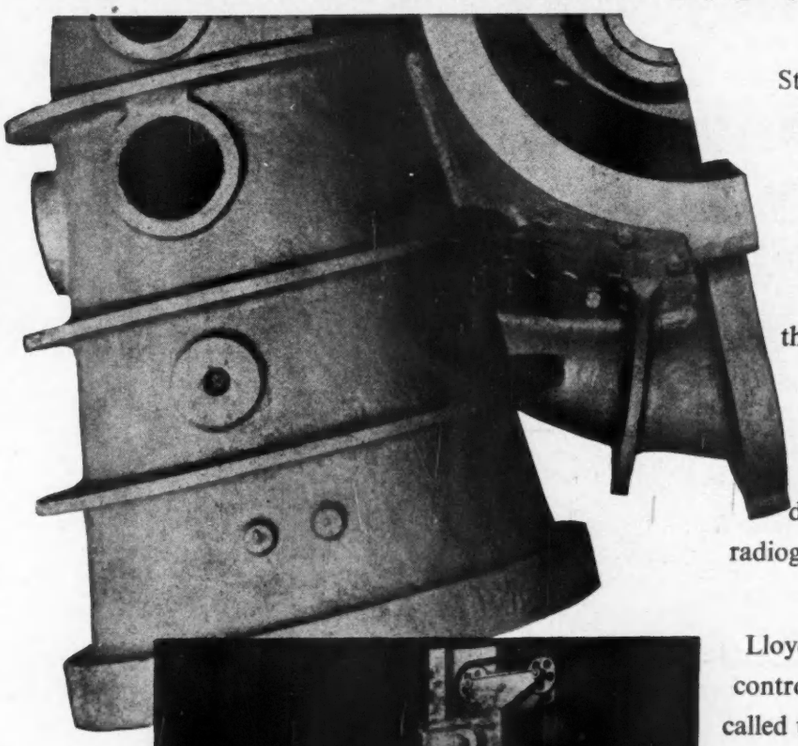
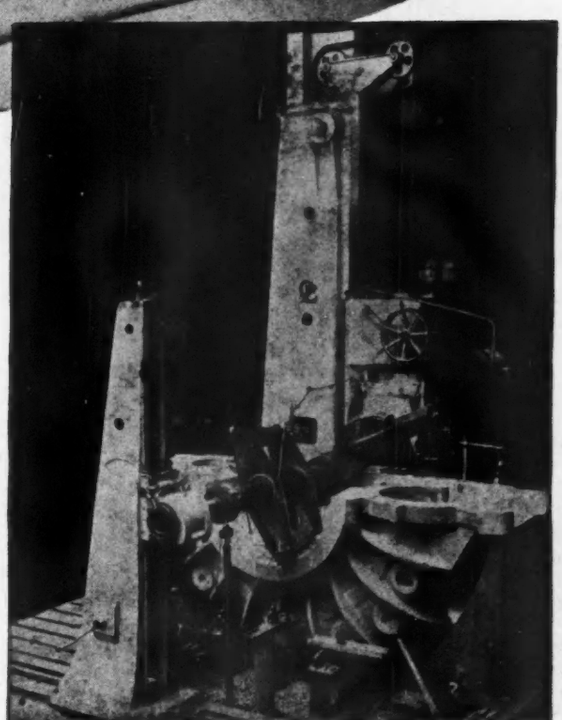


Half gas circulator casing cast in steel and machined for C. A. Parsons & Co. Ltd. for Nuclear Power Station, Calder Hall. Weight as cast 35 tons. Sectional thickness max 7" min 1½". Reproduced by permission of C. A. Parsons & Co. Ltd.

cast and machined for an important part





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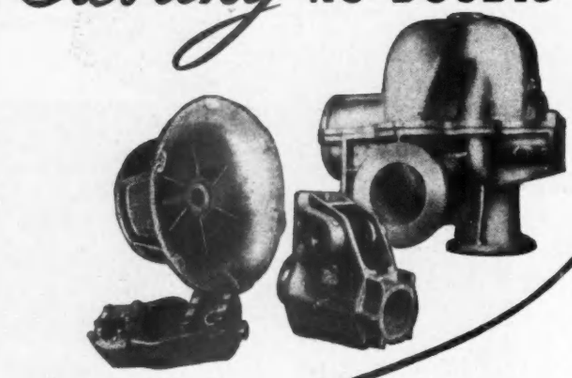

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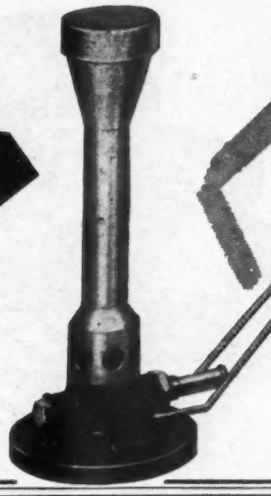

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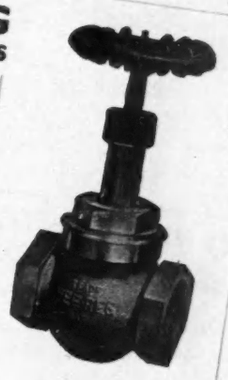

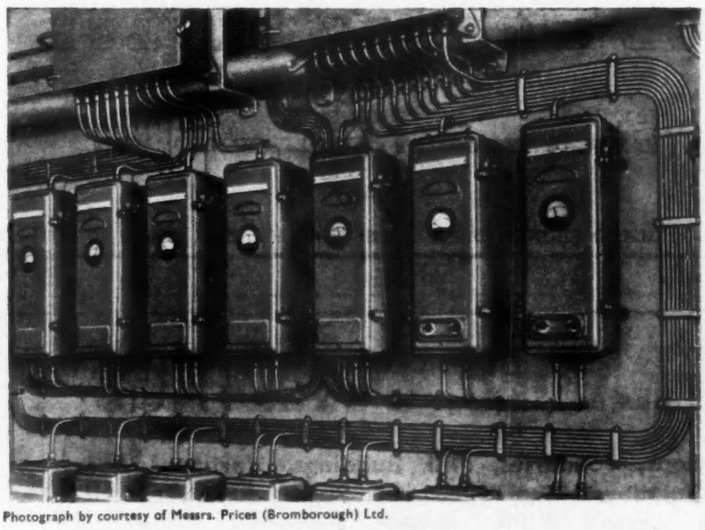

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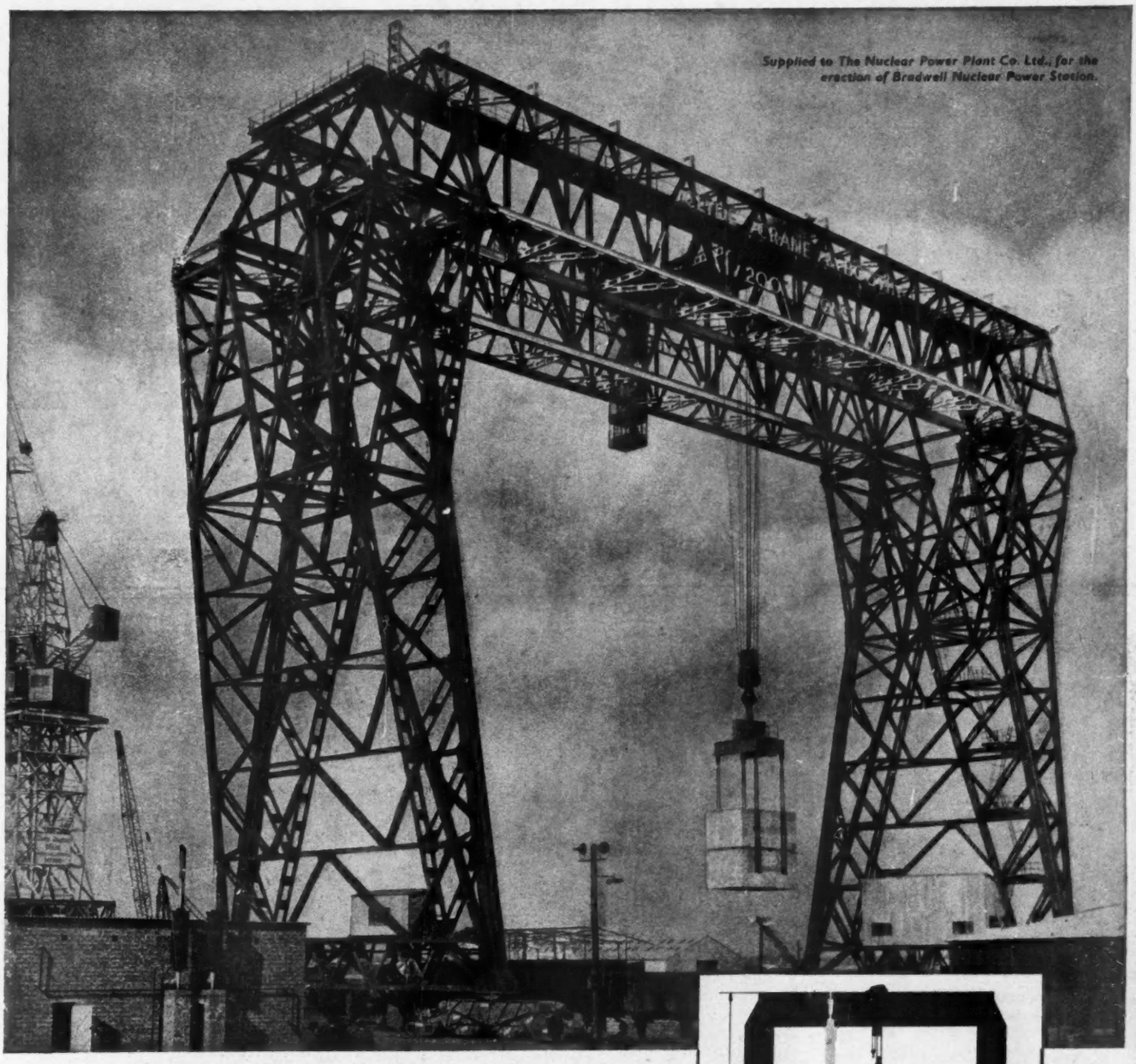

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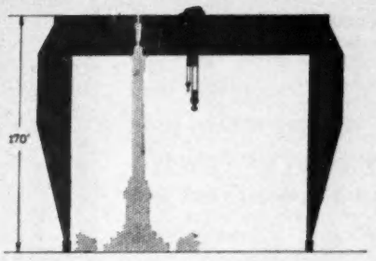

The Booth Goliath showing Nelsons Column on the same scale. Clearance from rail level to underside of bridge is 140'. Distance between rail centres 178'.

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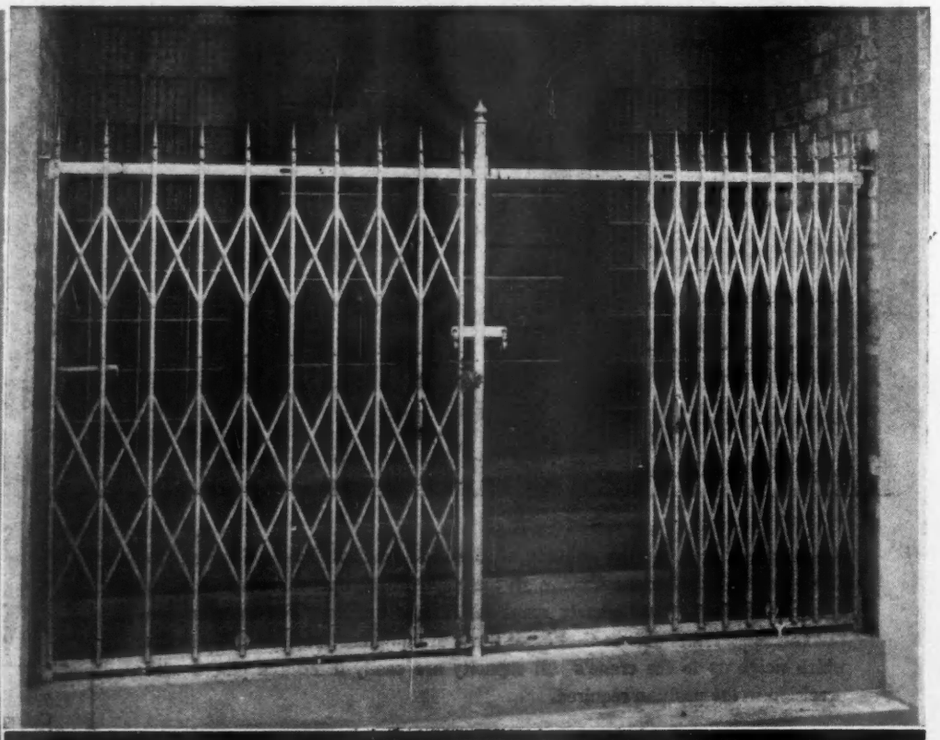

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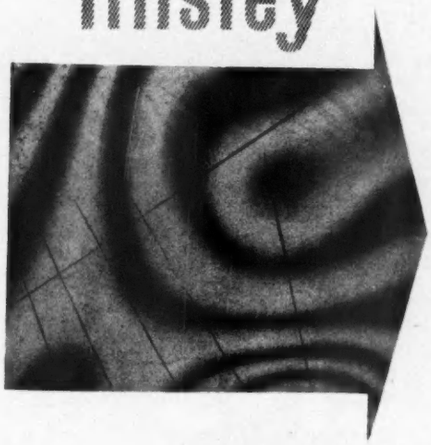

strain gauges

Electrical wire resistance strain gauges are accepted by engineers as one of the most important means of investigating stresses and strains in all types of structures and machines. The electrical resistance strain gauge consists of a grid of fine wire bonded to a paper or Araldite membrane which can be cemented to the surface under investigation. Connections are taken from the gauge to apparatus designed to give reliable and quick readings of the strain being measured.

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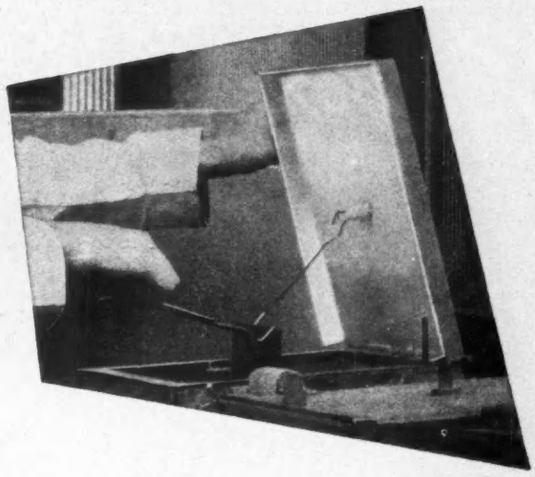

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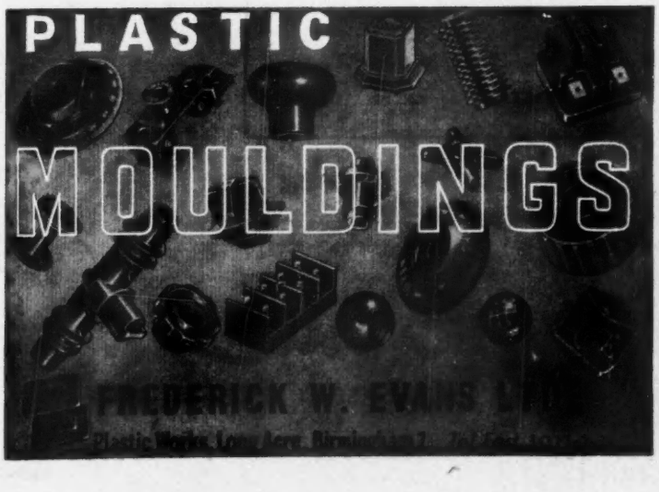

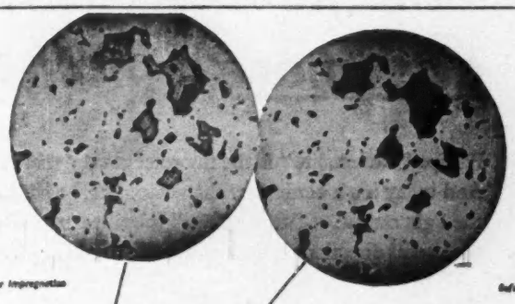

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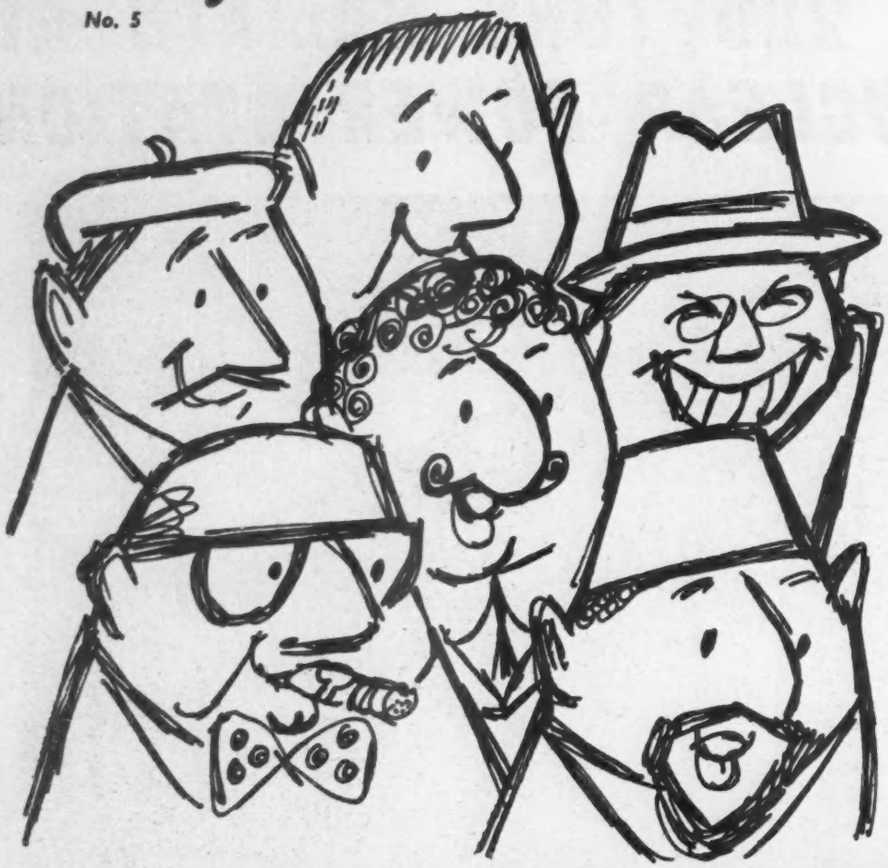

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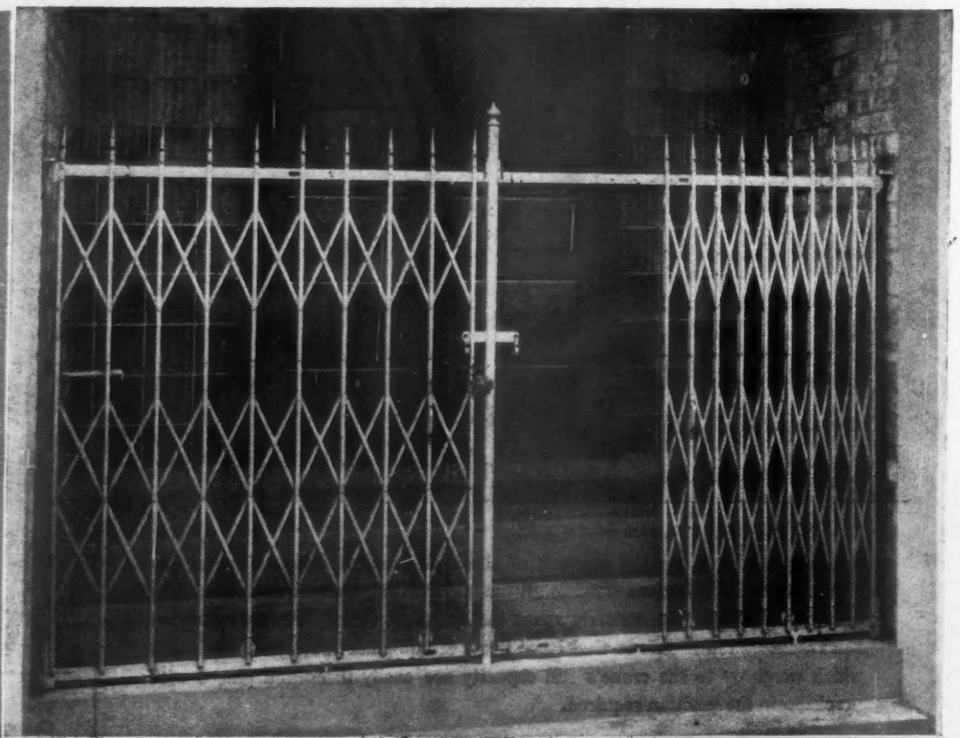

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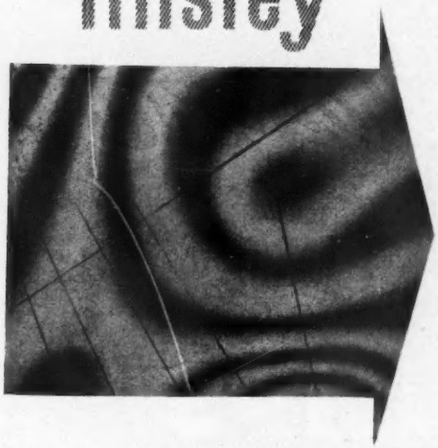

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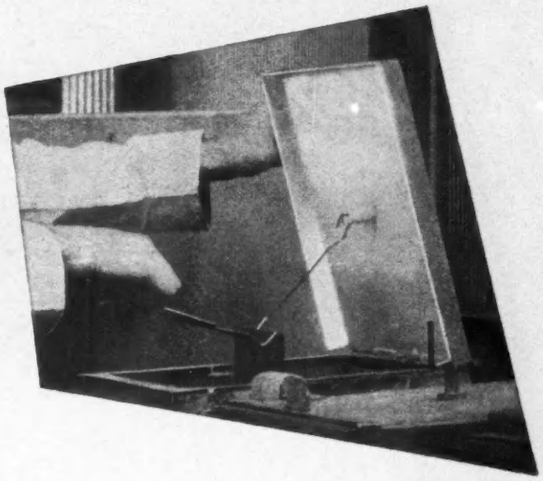

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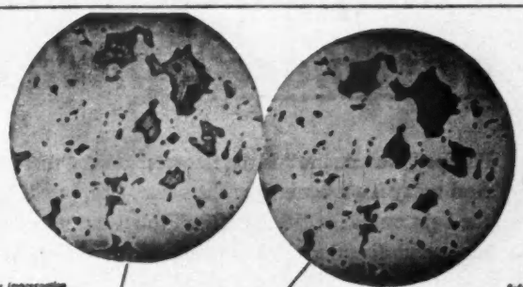

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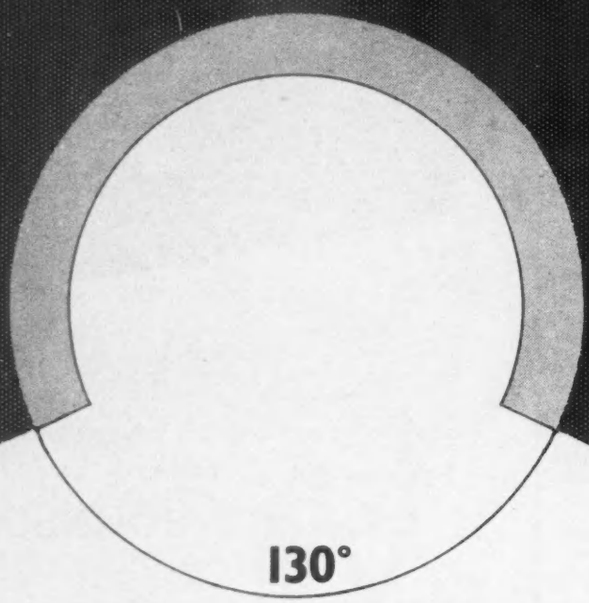

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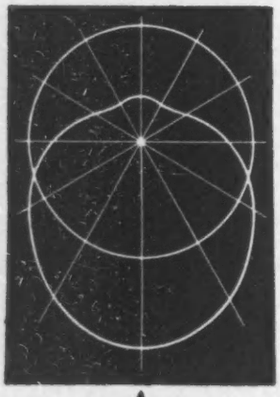

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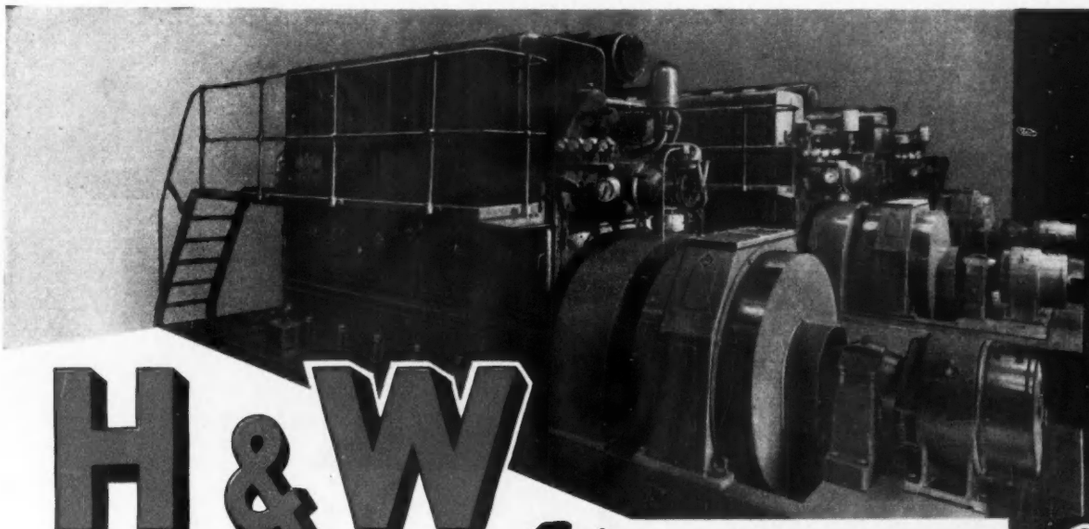

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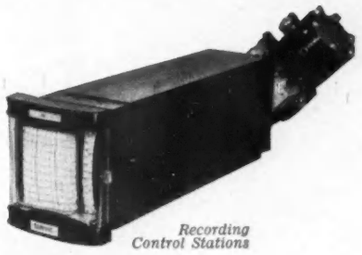

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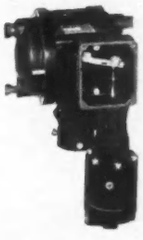

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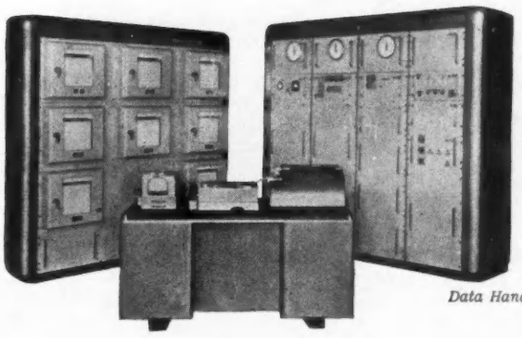

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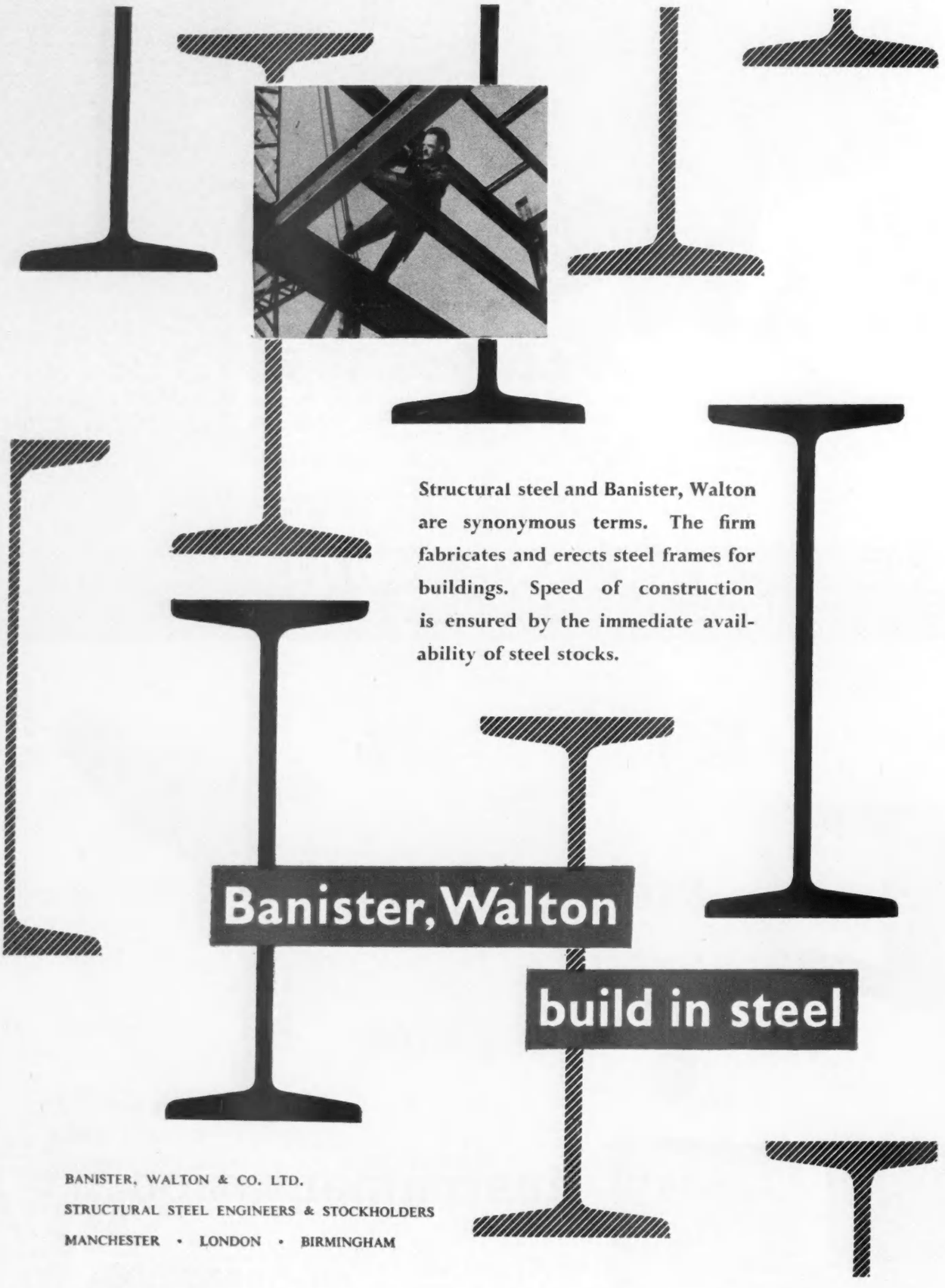

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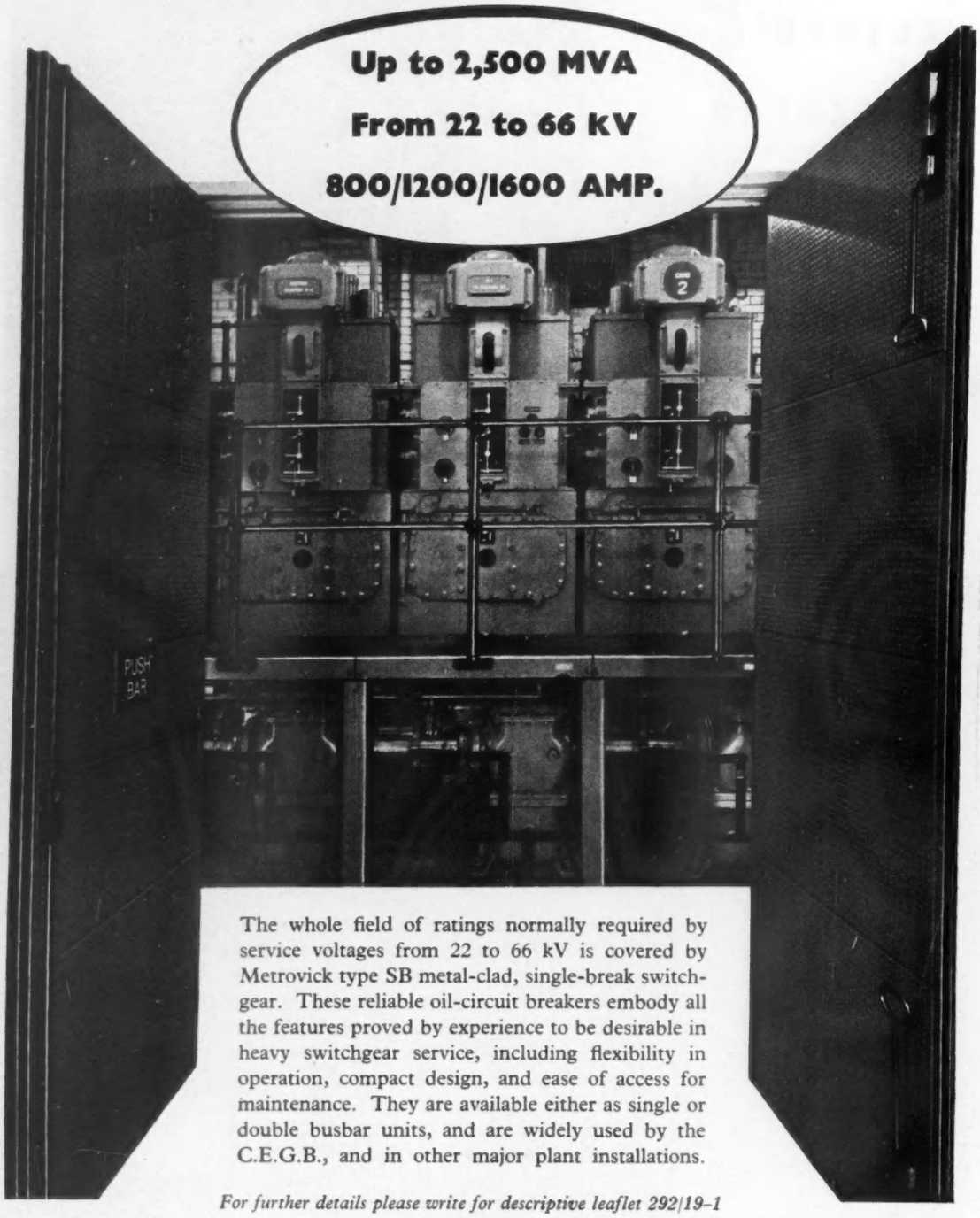

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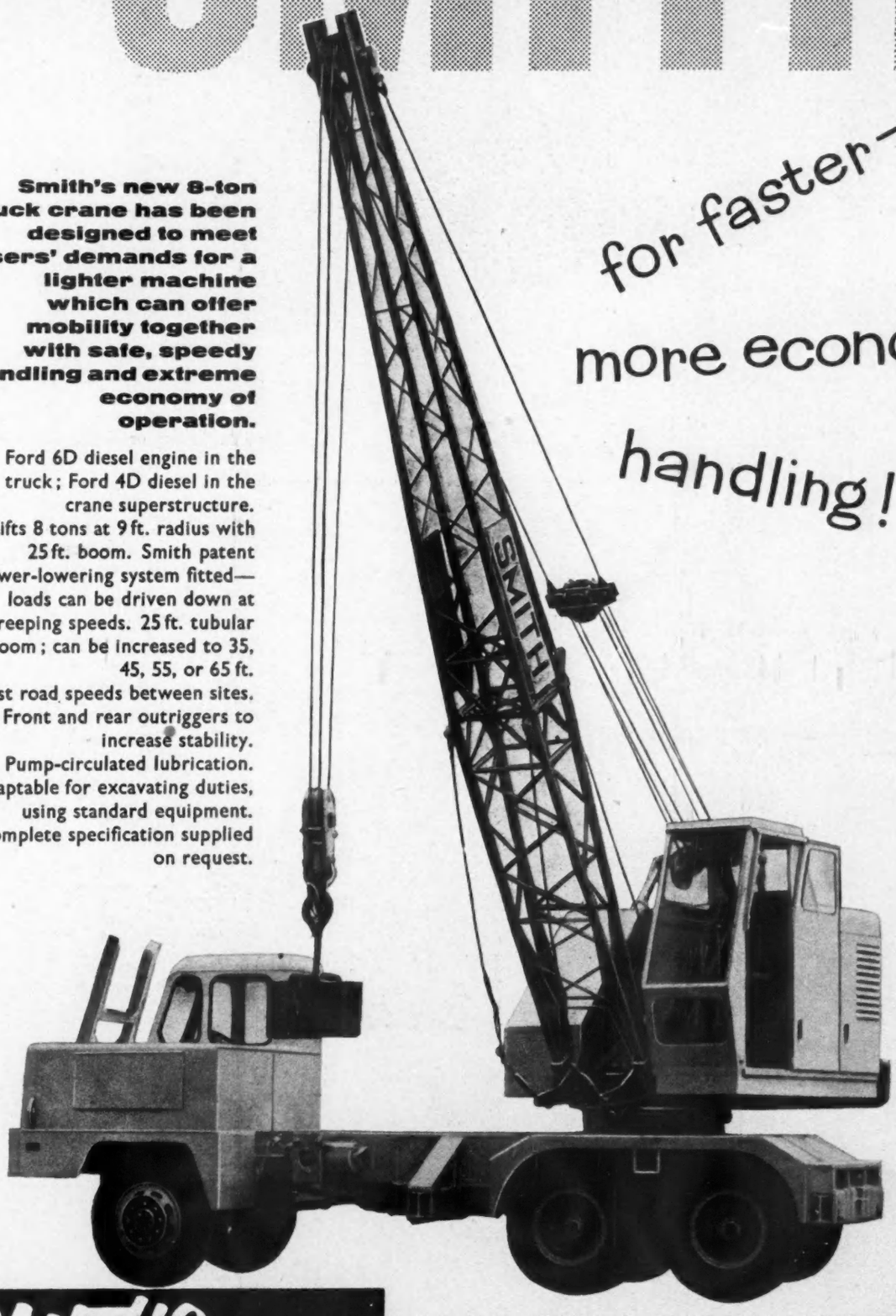

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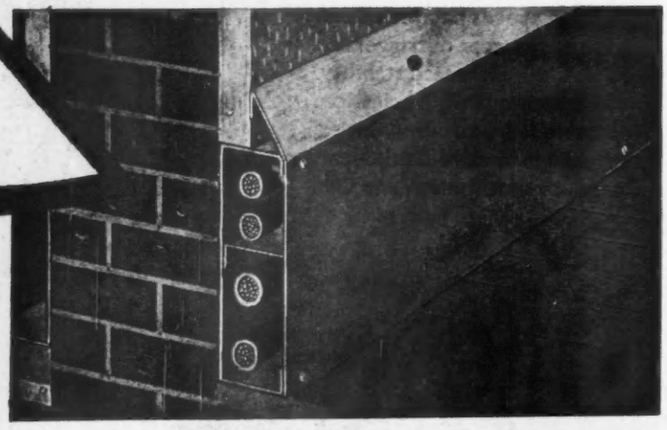

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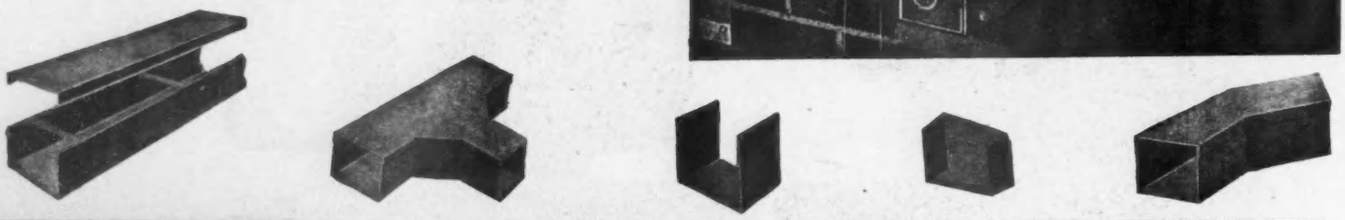

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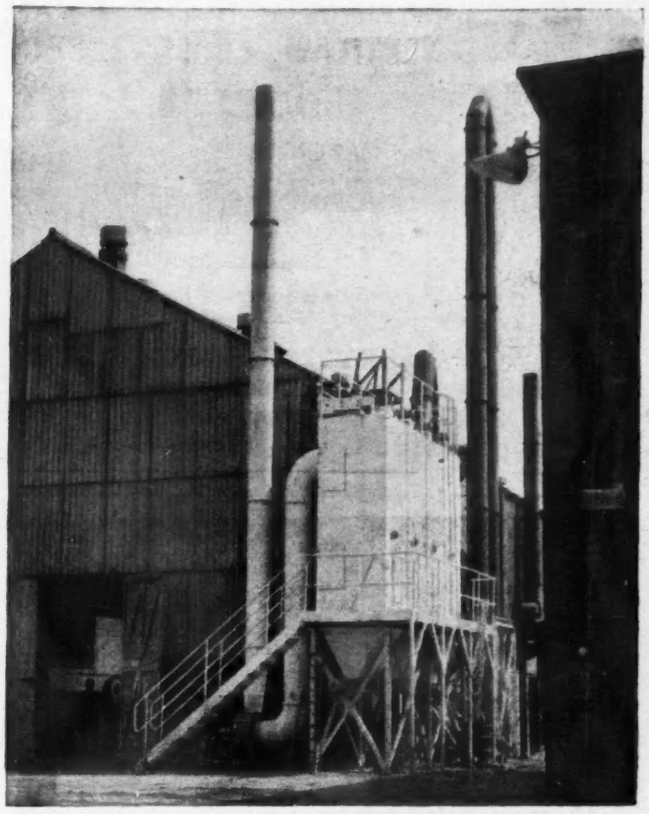

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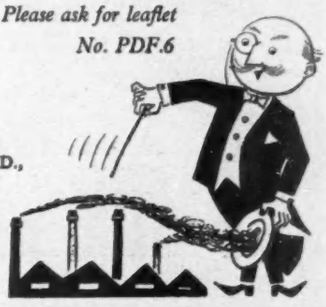

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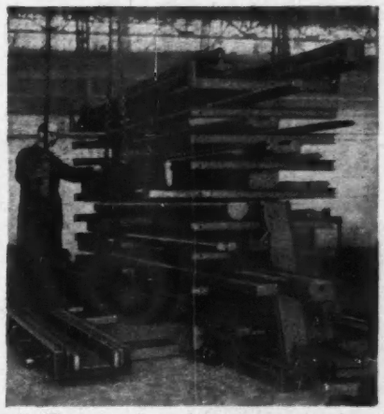

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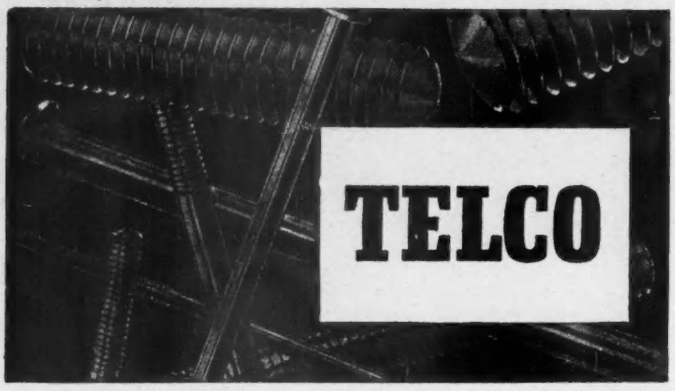

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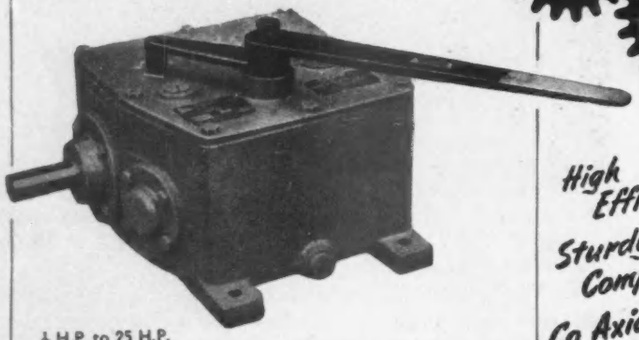

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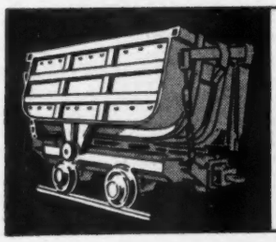

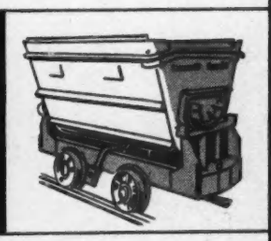

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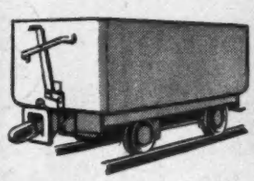

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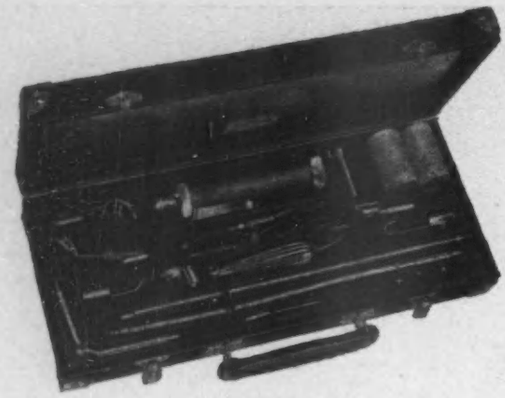

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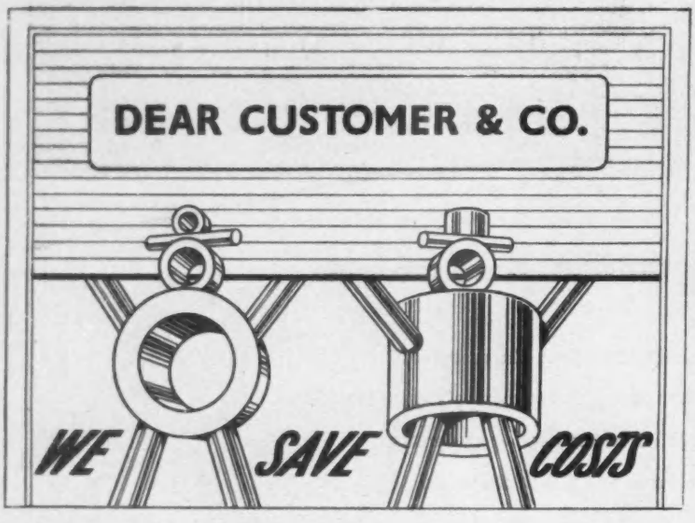

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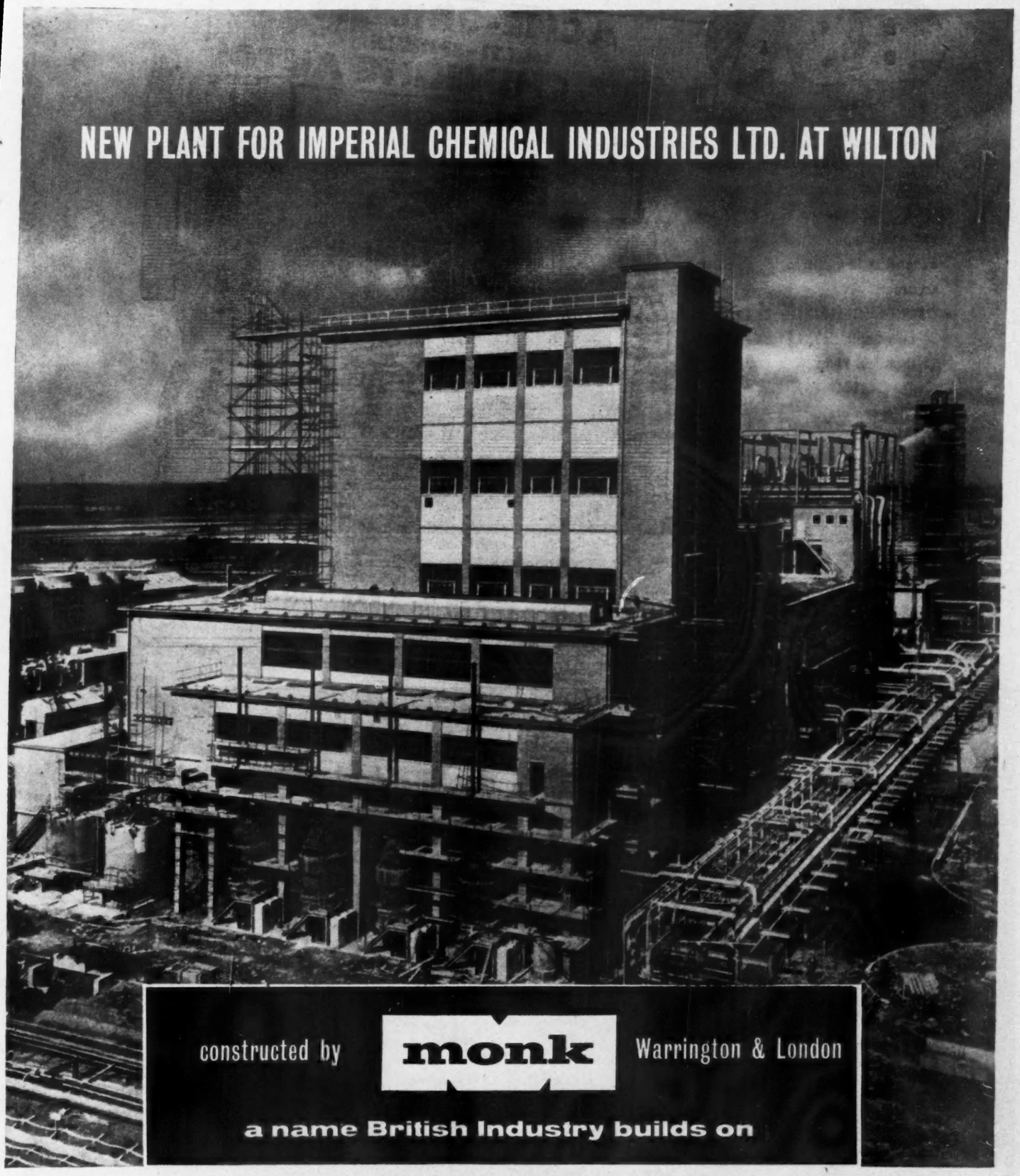
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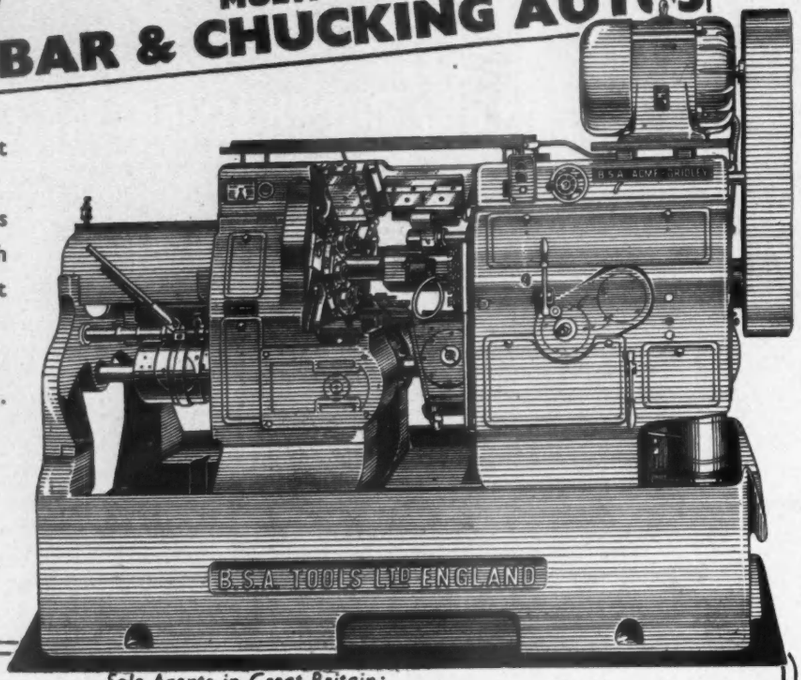

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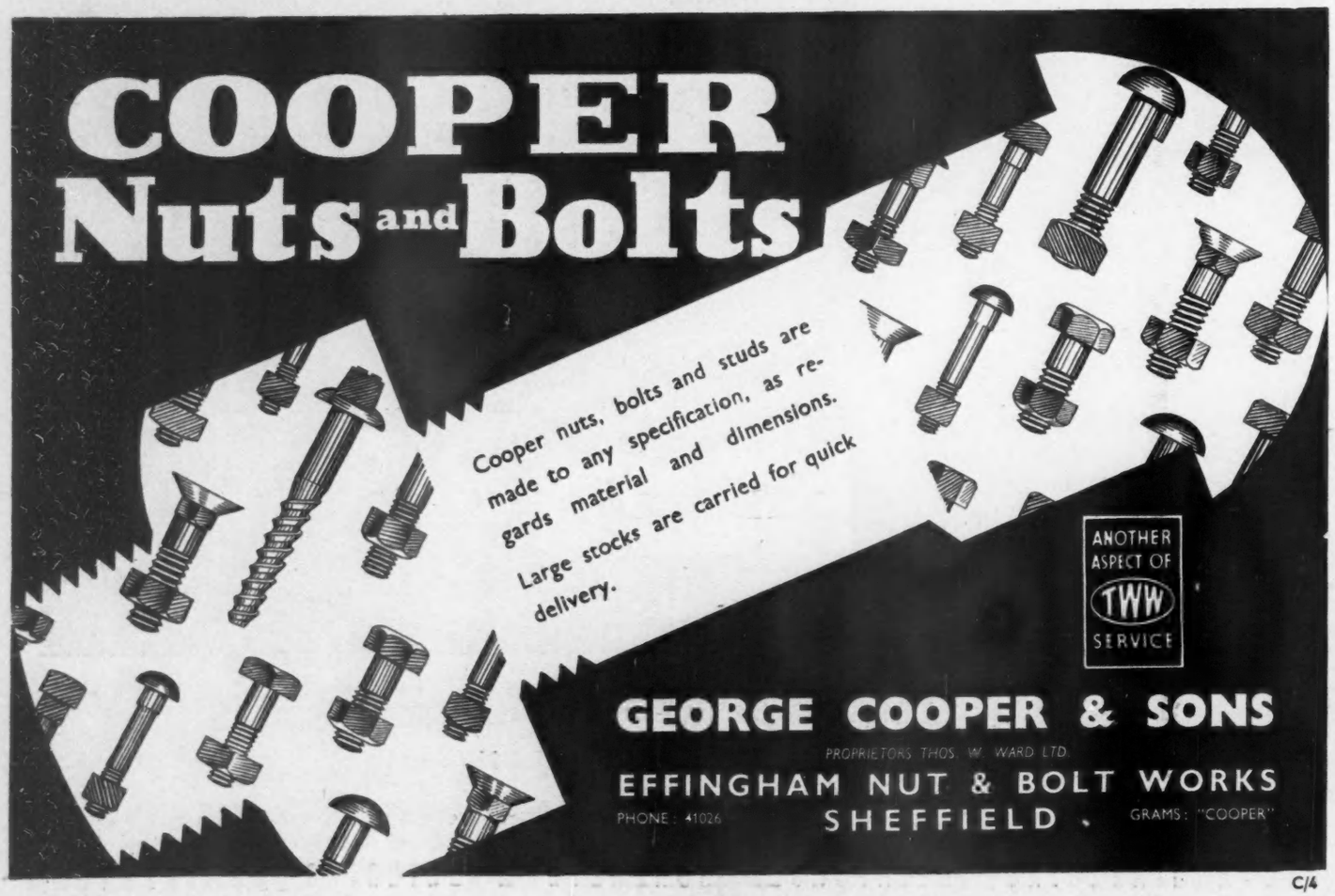

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THE ENGINEER

No. 5353 AUGUST 29, 1958 VOL. 206

ATOMS FOR PEACE

At the end of 1953 President Eisenhower addressed the General Assembly of the United Nations, and as a result of what he said it was decided to hold an international conference on atomic energy for peaceful uses. The conference was held in August, 1955, and in spite of the fears that were expressed concerning its possible degradation to a propaganda meeting, the event was wonderfully successful. Masks of secrecy were let fall in great numbers, not only in the " western " but also in the " eastern " world, and quantities of information were released for the first time. For the first time, therefore, results could be compared internationally, and the fresh air that blew through the barbed wire surrounding government laboratories was exhilarating enough to remind the occupants of earlier and happier years. While communication was not quite free at the conference, the atmosphere had the fresh tang that brought memories of scientific liberty back to many who once had enjoyed it. More than a thousand papers were submitted, and within eight months an English version of the proceedings was issued, in sixteen volumes. The results of the conference were so satisfactory to everybody involved that a repeat performance was planned. This coming week, therefore, on Monday, September 1, the second international conference on the peaceful uses of atomic energy will begin. The number of papers submitted for this second conference is much more than double the number presented at the first ; the average length of these papers is also greater than it was in 1955, and an early estimate makes this extension amount to about 40 per cent. There is little reason to doubt that the value of all this matter will be at least in proportion to its volume, but we cannot hope for the same sense of revelation as was experienced three years ago.

While we may take for granted that the scientific value of the conference will be great, as it was in 1955, there are some more material respects in which this second international gathering will show advances. In addition to the scientific exhibition that will accompany the conference, with twenty-one nations showing what they are doing or hope to do, there will be a commercial exhibition run by the Swiss authorities in Geneva. Here there will, no doubt, be much space devoted to projects for the future, but the nuclear power that is the subject of this exhibition has already fully emerged from the laboratory and the planning offices ; the hardware shown at the Palais des Expositions will be there as saleable goods, offered in what is already a highly competitive market. There will be artists' impressions of nuclear power stations on many stands, but in a substantial number of cases these will not be fanciful visions of what might be, but sober pictures of what is actually working or being built. It is in this field of *realisation* that Great Britain in particular shines, and perhaps outshines all the other participants. It is completely just that the British section at the commercial exhibition should be the largest national display, for undoubtedly this country has gone farther than any other in turning the new source of energy swiftly to productive use. An impressive picture is given of a British nuclear power industry that is still expanding, an industry, moreover, that is still not fully stretched in its capacity to give both to the domestic power programme and to other countries.

The British section, incidentally, affords an instructive comparison of what is in some ways the still fluid situation in this country to-day. All five of the great consortia are, of course, represented, and it is interesting to observe that both the closely and the loosely knit examples appear to be doing well. One occasionally hears whispers of disharmony in cases where extreme centralisation of power in a consortium has not taken place, but the work done seems to contradict these suggestions. On the other hand, as Lord Coleraine has recently said, nuclear engineering involves the synthesis of many aspects of engineering science ; heat transfer, metallurgy, control and concrete technologies are but some of them, and, while each is a specialised field, the quality of nuclear engineering is such that no independent decision can be taken in one without affecting decisions in other more or less remote fields. This problem of interaction is, of course, by no means either novel or unique. It confronts the small electrical circuit designer as well as the large-scale process control engineer. However, in a new and still immature industry of such magnitude, one can see that the future must depend greatly on the form of organisation adopted. Clearly, in a rapidly advancing technology, design and research will go hand in hand, and it may be desirable, as Lord Coleraine has suggested, that a central design organisation should govern the experimental programme of any one consortium. This can, of course, be achieved by a loose combination of independent companies, and on the face of it there is no reason why, with goodwill, the optimum proportions of centralisation and autonomy should not be equally well achieved by lightly as by tightly bound groups. While Lord Coleraine sees evidence that the group with the former kind of constitution is moving toward the group with the latter, it is perhaps too early to judge with certainty which, if either, has any material advantage. It is well for this country that the size of the nuclear power programme leaves room for different forms of organisation to be tried. Certainly all the consortia are making a brave show at the international exhibition in Geneva, and we must wish them the success they deserve in their markets abroad.

RESEARCH AND ACCOUNTANCY

Research workers and commercial accountants can never feel quite at ease in each other's company. For every research worker feels that it is not possible to assess with any pretence at accuracy the eventual value of his work, since any addition to knowledge is priceless. But the accountant can never feel entirely happy unless he is convinced by figures that he is getting value for money spent. It is not reasonable, therefore, to expect that a

Select Committee on Estimates reporting to the House of Commons about the work of the Department of Scientific and Industrial Research should be wholly satisfied with the results of its inquiries. The Committee, in a report published at the beginning of this week, comments, for example, unfavourably upon the wide variation in " receipts as a percentage of expenditure " of the various D.S.I.R. establishments. They range from 95·4 per cent for the Fire Research Station (which is supported as to half its costs by the insurance companies' Fire Officers Committee) to 0·3 per cent for the Radio Research Station. In particular, the Committee singles out the Building Research Station, the Mechanical Engineering Research Laboratory and the Food Investigation Organisation for criticism and it recommends that these bodies " should approach the question of recovering money from industry with a greater determination." We hope they will do no such thing ! The Mechanical Engineering Research Laboratory, for example, conducts research primarily in the basic and generic aspects of mechanical engineering science. It is quite impossible to say that any one firm or another or even any one industry more than another will benefit directly from the kinds of research it mostly does. Moreover, it is also impossible to allow for the undoubted fact that once a piece of fundamental knowledge has been discovered it will be used far into the future by firms and organisations not yet born at the time of the discovery. It is surely, therefore, fundamentally mistaken to suggest that the first users of the discovery should pay for it. The point is well illustrated by a research being undertaken by the Building Research Station. That Station is making measurements of the effect on the Bakerloo tunnel in London of removing and replacing the earth cover while the new Shell building is being constructed above. The Committee recognises that " the work is of great value to the Department in connection with its study of tunnels." It also sees that the work may be of value to the Shell company " in that it is helping to reduce their risk of causing damage to the tunnel." On those grounds it recommends that " in future, where it seems possible that any work carried out by the Department for its own purposes may incidentally result in direct advantage to an individual firm an agreement should be negotiated with the firm concerned before the work is started whereby the firm should pay a contribution to the costs of the work, if, in fact, the firm obtains a direct advantage as a result of the work." The argument is demonstrably cock-eyed. It can only have been put forward out of a mistaken notion that any knowledge gained by the Department was solely confined to circumstances at that particular site ; or alternatively with the commercial idea in mind that the Department could or should keep the knowledge secret so that it could " sell " it to the next comer. In fact, it is the obvious duty of the Department to publish its findings and those findings no doubt (for why otherwise is the Building Research Station so interested ?) will be applicable upon other sites in London and perhaps elsewhere. In these circumstances what is the justification for asking only the Shell company to contribute when in fact it happens to be merely the first of an unnumbered series of companies which will benefit ? Furthermore, what would happen if a firm approached in such a way as the Committee recommends refused to " play " ? Would the research body then not carry out the research ? That surely would be to cut off its nose to spite its face. Then could it refuse to reveal the results of the research to the firm concerned ? Surely not, for it is the research body's plain duty to publish its scientific findings! In short, not only would it be, in our view, improper for a D.S.I.R. research body to attempt in any way to charge industry for the use of its fundamental research discoveries since the researches are conducted for their value to the community at large, but the research body has nothing to sell ! The situation is, of course, quite different when Research Associations are involved. For those Associations do their work for the benefit of their members to whom alone the results are communicated. They have in fact a secret to sell which is not revealed to the community at large.

It is really rather curious that the Committee should have failed to see that D.S.I.R. establishments, in making fundamental discoveries and having a duty to publish them, make it impossible for themselves to charge any individual firm for the benefit received. For the Committee in another part of its report is concerned to criticise the information services of the D.S.I.R. establishments. Only a page or two away from that section of the Report in which the Committee criticises the Building Research Station for not extracting money from the Shell company the same Committee is found criticising research bodies for not approaching individual firms who might be expected to be interested in particular results achieved by the establishment. There is no suggestion whatever that any attempt to extract payment should be made. The object of the approach would be to get discoveries used by industry. In one other recommendation we incline to think the Committee also wrong. The Committee is of the opinion that the Pest Infestation Laboratory, the Radio Research Station, the Road Research Laboratory and the Water Pollution Research Laboratory, each of which is " concerned mainly with work for Government departments," should be taken out of the control of the D.S.I.R. and placed under an appropriate Ministry. But it is our impression that these laboratories will do far better work when relatively free from the control of the Ministries which they primarily serve. Research and research men are better likely to be understood by the D.S.I.R. than by any other Government department.

ECONOMICS OF THE COHEN COUNCIL

It is, we think, quite a grave misfortune that the Trades Union Congress should have decided, after a single experience of co-operation, no longer to discuss its views with the Council on Prices, Productivity and Incomes. For in consequence all the bodies which the Council now consults tend to think in orthodox and conservative terms. No one is left to present views, whether mistaken or not, which orthodox economists will not accept ; and no one is left to argue the left-wing case. Very naturally, in consequence, the second report of the Council, which lies before us as we write, must certainly be regarded by economists of the left not as an independent and balanced discussion of the nation's economic affairs, but as a partisan document. But the very object for which the Council was set up was to review the economy dispassionately. We fear in the circumstances that the reports of the Council are likely, as the years pass, to suffer the same kind of loss of prestige as has been suffered by the Government's Economic Surveys, the more particularly as the Council seems to be largely duplicating what is done more exhaustively in the surveys.

We report elsewhere some of the conclusions reached by the Council. We are primarily technical people, not able to argue the economic toss with the Council. But we cannot

help regarding the Council's ideas as depressing. For a rapidly expanding economy devoting a substantial fraction of its output to investment in higher production must unquestionably be the one which most rapidly will raise living standards. It is also the kind of economy which is particularly exciting for technical men to experience, since it stimulates inventiveness in production methods and makes it easier to interest financial people in developing new products. But the Council, because governmental policies have made sterling strong in the international market and because there is some hope of stopping inflation at home, seems content that the rate of industrial output should remain static or, at least, increase only slowly. One cannot help asking whether it really is preferable for the human race to damp down expansion in order to hold currencies stable. Alternatively, one can ask whether the choice really is between rapid expansion and unstable currencies, on the one hand, and a low rate of expansion and stable currencies on the other ? Is it not time the economists learnt more about their subject so that they could either recommend practical policies combining high rates of expansion with stability ; or inform the world that such an ideal cannot be approached? The world would then be presented with a clear choice between expansion plus slow inflation, or stagnation plus a stable price level. We do not think there can be any doubt which is the lesser evil. We do not choose at present between them, only because we retain the hope that the ideal is attainable.

RURAL INDUSTRIES

A frequent comment on present-day progress is that the face of Britain's countryside is continually changing. Quite apart from the new towns, there are essentials such as power stations, transmission lines and sewerage and other public works which now have a place in many a landscape. The few may sometimes say that these things are an offence to the eye, though most rural populations, we believe, are ready to acknowledge the benefit they derive from amenities which but a short time ago were normally restricted to town dwellers. But the paraphernalia of the public services is by no means the only thing that is changing the face of the countryside. During the second world war security demanded a considerable dispersal of industry. That may well have inspired the steady drift of industry away from urban to rural areas that has been going on in the post-war years. Modern factories accommodating light engineering and other businesses are being built in places that only a few years ago were considered to be positively in the " back o' beyond." These new factories add something to the value of rural areas, even though the critic may aver that their presence is a blot on the idyllic charm of past days. But it may be a long time before modern factories of the kind we have in mind are looked upon as a really integral part of rural industry. In all country areas there are trades—many of them have been practised for centuries—which seem to fall naturally into the classification of " rural industries." They are crafts which, through the years, have demanded the alert mind, the trained eye and the deft hand of those who have become expert in them. These trades and crafts may not now always flourish as abundantly as they once did, but they, nevertheless, continue to make a valuable contribution to Britain's technology.

An interesting account of the present state of this country's rural trades and crafts is regularly given in the annual reports of the Rural Industries Bureau. The latest of these reports, which deals with the year ended March 31 last, is as valuable as its predecessors. The Bureau exists to provide technical advice and assistance to country workshops ; it is concerned with improving and bringing up to date the techniques and business methods employed in rural industries. The chapter of the report devoted to rural engineering workshops is of particular interest. In the main, these workshops are the successors to the village smithy with its dim interior and large heap of ancient scrap just outside the door ! The report puts on record that, during the past year, there has been " a remarkable surge of development in kinds of work and techniques not previously associated with these businesses." This change, the Bureau suggests, is linked with the adoption and development by " big industry " of new materials and processes and with the desire of country engineering workshops to adapt these to their activities ; it is a development which the Bureau is glad to encourage. Among the subjects on which the advice of the Bureau has been sought in recent months, the report mentions gear generating machines, jigs for batch production, improved finishes for metal products, foundry equipment, electronic equipment and argon-arc welding equipment. This certainly provides a striking contrast with the early years of the Bureau's activities. Another matter on which the report comments is the increase in the number of new and rebuilt workshops. Here again the expert advice of the Bureau's staff is regularly sought. In short, there is obviously in rural workshops a greater awareness of the importance of layout, more interest in ways of making better use of tools, equipment and floor space, and in getting the utmost advantage out of what is available. It might be easily assumed that these are matters to which detailed attention is given only by the larger industrial concerns. The Rural Industries Bureau, however, makes it plain that the fruits of technological advance are by no means confined to " big industry." Its continued efforts to encourage the country workshop to share those fruits are clearly worthwhile.

The Engineer— 100 Years Ago (AUGUST 27, 1858)

" AMERICAN STEAM CARRIAGE FOR COMMON ROADS."

" A small carriage has during the past few months been driven about the streets of New York and from the novelty of the vehicle, it has attracted a great deal of public attention. The inventor of the carriage is Mr. Richard Dudgeon, a mechanic of English birth. It is an odd looking machine, and has the appearance of an artillery wagon, from its low size and projecting boiler, which is not unlike a cannon. The weight of the carriage is 2,700 lb, and it may be described as a half or quarter sized locomotive without any funnel. It has no peculiarity in the arrangement of the steam machinery, which is a simple tubular boiler with improved valve gear. The steam and smoke are discharged downwards in front without a chimney, and pass behind a water tank on the front end of the boiler. The cranks are worked on the inside, instead of the outside, as in other locomotives.

" The improvements over other engines principally consist in increasing the stroke of the piston, and diminishing the size of the driving wheels, the stroke being eighteen inches, and the diameter of the wheels three and a half feet. The carriage wheels are very similar to those in ordinary use, but larger, in order to diminish the jolt. The steam power is applied to the hind axle, and the steering is done by the front wheels, by means of a stout iron rod, armed with a screw at one end, which moves the wheels according to the direction it gets from the cranks under the control of the driver, who sits behind the boiler . . . Twelve miles per hour can be run by the carriage on a hard road with the greatest ease, and this, of course, leaves a margin for improvement in the construction of other steam vehicles. The cost of the carriage is 1500 dollars, or about £300. Should these steam carriages come into general use, it would be on roads made for the purpose, as they are hardly suitable for running in the streets of crowded cities, in consequence of the alarm they would cause among horses."

"Atoms for Peace" Exhibitions at Geneva

The Second International Conference on the Peaceful Uses of Atomic Energy begins in Geneva on Monday, September 1. Concurrently with the Conference an exhibition is being held in a special structure built in the grounds of the Palais des Nations. Floor space to the extent of about 90,000 square feet is provided, and twenty-one governments have stands. A commercial exhibition is taking place simultaneously at the Palais des Expositions, and here some 300 exhibitors from thirteen countries are participating. We give below a necessarily rather cursory survey of the exhibitions, and a brief account of some of the stands in the British section of the commercial exhibition.

THE second United Nations International Conference on the Peaceful Uses of Atomic Energy begins in Geneva on Monday, September 1. The first conference took place in August, 1955, and a scientific exhibition in the Palais des Nations was part of the event. For the second conference, which is on an even grander scale than the first, the accompanying show is correspondingly larger. The scientific exhibition in 1955 covered about 20,000 square feet and nine countries took part. This year the space in the Palais has not been enough for the twenty-one governments that are participating, and a temporary building has been erected between the Secretariat wing of the Palais des Nations and the lake. It is a rectangular structure 548ft long by 164ft wide, with a height of 40ft in one section and 18ft in the other. There are about 90,000 square feet of floor. The architect responsible was Peter Steiger of Zurich and construction was by Etablissement Casai et Cie, Geneva. The cost of the building has been met by the exhibiting governments. The scientific exhibition will be open from August 31 to September 15, some periods being reserved for conferees. The exhibiting governments are Argentina, Australia, Belgium, Canada, Czechoslovakia, Denmark, France, German Federal Republic, Hungary, India, Italy, Japan, Norway, Spain, Sweden, Switzerland, Union of South Africa, U.S.S.R., United Kingdom, United States and Venezuela.

The section on controlled thermonuclear fusion reactions includes a historical description of research in the United Kingdom, models of "Zeta," "Sceptre III" and A.W.R.E. apparatus; an account of the researches at four American laboratories, Los Alamos, University of California, Princeton and Oak Ridge, illustrated by operating devices; and Russian models, diagrams and equipment. The section is generally intended to supplement discussions at the conference, at which nearly a hundred papers will be delivered on the subject, and where descriptions will be given of such devices as the British "Zeta" and "Sceptre III," the American "Stellarator," DCX and "Pyrotron," and a Russian toroidal discharge chamber.

Reactor Section

The reactor section includes the following national displays:

United Kingdom.—Among the models of reactors on view is one of the high-temperature gas-cooled experiment at Winfrith Heath. There are also models of the nuclear power stations at present being built for the Central Electricity Generating Board. Aspects of power research are portrayed, and such subjects as surveying for raw materials, research on fuel elements, instruments, chemical processes and the disposal of fission products are dealt with also.

United States.—A 10kW "Argonaut" training reactor, and "Triga," a training, research and isotope-producing reactor, are shown in operation. There is a full-scale model of the pressure vessel and core of the pressurised water reactor at Shippingport, Pennsylvania, and scale models of other civil power reactors working or building in the U.S.A. An operating laboratory illustrates health and safety techniques.

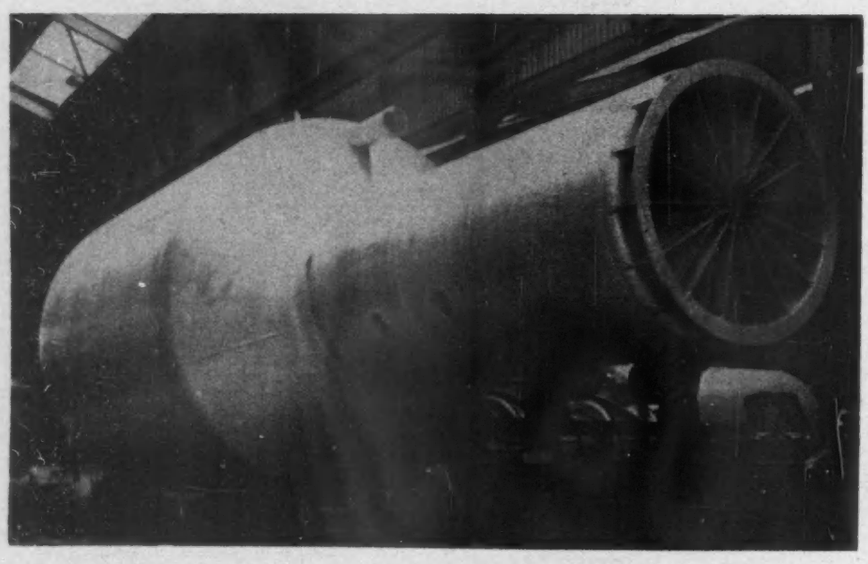
France.—The exhibit describes plans for electrical power generation by the prototype reactors at Marcoule. A model shows the various experimental facilities of the EL-3 research reactor at Saclay.

Italy.—The CP-5 research reactor under construction at Ispra is represented by a model. Uranium production plant is similarly dealt with.

Norway.—A model is shown of the boiling heavy water reactor that is now nearing completion at Halden. There is also a model of the pilot fuel processing plant at Kjeller.

Sweden.—Models of two reactors being built to produce heat and power, the R3 and "Adam," are displayed, and an exhibit is devoted to the experimental facilities at the new research station at Stuesvik, including models of the zero-energy reactor RO and the material testing reactor R2. The new 1000 MeV electron synchrotron at Lund is represented by a model.

The Swiss authorities in Geneva have also arranged a commercial exhibition, independently of the United Nations, and this is taking place in the Palais des Expositions. Thirteen countries are represented by some 300 exhibitors in what is described as the largest display of industrial and commercial applications of atomic energy yet seen in the world. Of the 200,000 square feet of space (twice as much as in 1955), 40,000 square feet are occupied by the British section. Some of the principal stands in the latter are mentioned individually below. The American section occupies about 32,000 square feet, and its focal point is a full-scale model of the core of a 150MW nuclear power plant. Surrounding the model is a rotunda with displays describing the American atomic industry. Fifty-six companies exhibit on either side of the rotunda. Two actual reactors are shown. They are research and training reactors of the kind provided by the Atomics International Division of the North American Aviation Company and by Aerojet-General Nucleonics. These specimens are to be delivered after the exhibition to western European buyers. There is also a continuous film show. The French section is somewhat larger than the American and has about 100 exhibitors. Samples shown range from raw materials such as uranium ores to worked products such as graphite, zirconium



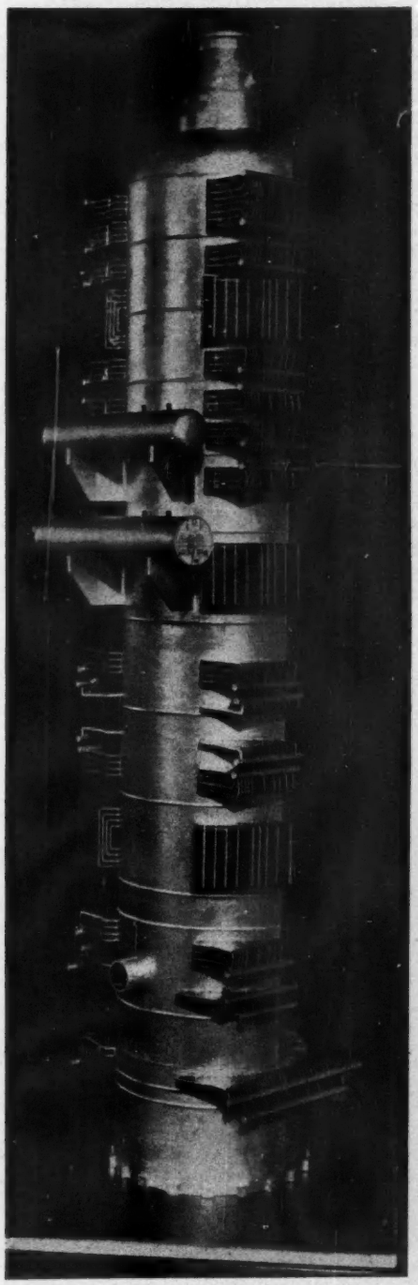
Shown on the stand of the A.P.V. Company, Ltd., is this core tank, fabricated in 99·5 per cent pure aluminium, for a "Merlin" research reactor as supplied by A.E.I.-John Thompson Nuclear Energy Company, Ltd., to the Stetternisch Research Station of the North Rhine Westphalia Government

and beryllium. A model is shown of what is claimed to be the only factory in the world constructed for the treatment of uranothorianite ores. There are models of reactors at Saclay and Marcoule, and of the 3000 MeV proton synchrotron at Saclay. Studies in propulsion are also illustrated. Again there is liberal use of cinematic film. The other countries exhibiting are Argentina, Austria, Belgium, Germany, Holland, Hungary, Italy, Liechtenstein, Sweden and Switzerland.

A.E.I.–John Thompson Nuclear Energy Company, Ltd.

This company is building a two-reactor, 275MW power station for the Central Electricity Generating Board at Berkeley, Gloucestershire, and was the first of the consortia (by a few days) to start work on a site for this purpose. A model of the Berkeley station is displayed on the company's stand, and may be compared with another model representing a 150MW single-reactor station of the kind that is offered for export. A model is also shown of "Sceptre III," the toroidal discharge tube with which the company is experimenting. This work, which aims at the control of a thermonuclear fusion reaction, is complementary to that done at Harwell on the well-known "Zeta" torus. The fourth model on the stand is of a "Merlin" research reactor. Two of these have nearly been completed in the U.K., and the company states that the "Merlin" is the first reactor of its kind and size to be sold in Europe by "British private enterprise."

The members of the consortium contribute individually to the display. John Thompson, Ltd., shows how the pressure vessels at Berkeley are being welded, and how the spheric container, liquid metal circuits, primary and secondary heat exchangers, steam and water plant and other parts of the experimental fast-neutron reactor at Dounreay were made. Metropolitan-Vickers illustrates, among many other matters, its part in the design and construction of "Zeta." The British Thomson-Houston control system, blowers and valves for Berkeley are demonstrated, and various instruments are shown by Sunvic Controls and Isotope Developments, Ltd.



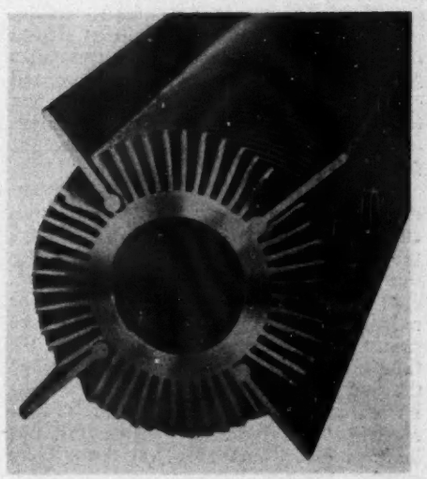
On the stand of Atomic Power Constructions, Ltd., is shown this model of a typical heat exchanger for a 500MW nuclear power station. Twelve of these would be supplied per station, each 84ft high by 20ft diameter and weighing 300 tons

Atomic Power Constructions, Ltd.

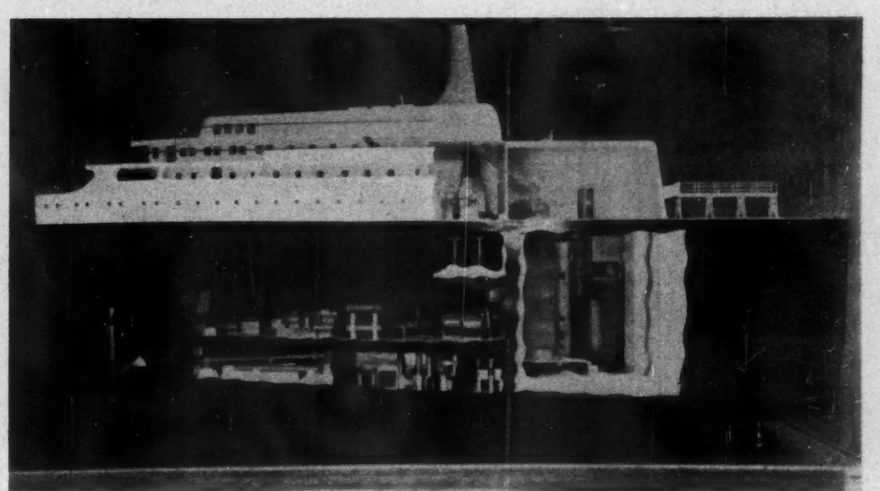
Of the five major consortia formed in the U.K. with the encouragement and co-operation of the Atomic Energy Authority this is the youngest. The aim of the company's display at Geneva is to demonstrate its ability to design, construct and commission nuclear power stations of all sizes. A drawing-office is included in the stand, complete with drawings of a power station for technical discussion. One exhibit illustrates the effort being devoted to research and development. Specimens show how rigidly welding is specified in various parts of a reactor. A broad picture is given of the layout and facilities at the company's central laboratories, with some indication of the research programme. A model of a 500MW station of the kind which the company would build for the C.E.G.B. is shown, and other exhibits are provided by individual members of the consortium. Thus, the Fairey Aviation Company, Ltd., displays fuel cans for Calder Hall and Windscale, and a magnetic resonance spectrometer for chemical analysis. International Combustion, Ltd., shows parts of a heat exchanger for a gas-cooled reactor, and Richardsons, Westgarth and Co., Ltd., shows a model of a turbo-alternator designed for the steam conditions of a nuclear power station. The last-named company also exhibits a bladed rotor of a model used in the development of carbon dioxide compressors for reactor cooling circuits.

English Electric–Babcock and Wilcox–Taylor Woodrow

The dominant theme of this group's stand is the 500MW station being built for the C.E.G.B. at Hinkley Point, Somerset. An illuminated coloured transparency measuring 20ft by 10ft shows the station in an advanced stage of construction, with the 400-ton "Goliath" crane lifting a boiler into position. A scale model of the completed station shows features not visible on the transparency, for example, the sea wall built to reclaim land for the turbine house, &c. Two other models, made to larger scales, represent a reactor and a boiler respectively; both are sectioned. Display panels on the stand deal with such matters as the research



An experimental helically finned fuel can made of magnesium alloy. The splitters are attached by a method devised by the Fairey Aviation Company, Ltd., a member of Atomic Power Constructions, Ltd.



Vickers Nuclear Engineering, Ltd., is showing a model of a 65,000-ton nuclear tanker. This is a cutaway section showing the advanced gas-cooled reactor. The pressure vessel for the latter appears in the square cutaway portion, the boiler immediately to the left of the pressure vessel, the blower drive to the left again, and finally, in the long central cutaway portion, the conventional geared turbine propulsion machinery is visible

and development being undertaken by the group, the support of the graphite core of a Hinkley Point reactor, the internal insulation of the top of the pressure vessel, and the evolution of boiler design. Detailed information on Hinkley Point is given in a plan of the station. As is by now well known, Hinkley Point is the latest, the most advanced and the most powerful station on which construction has started for the C.E.G.B., or indeed anywhere in the world.

General Electric Company, Ltd., and Simon-Carves, Ltd.

A full-size model of part of a reactor is here literally thrown open to visitors. Entering the mock-up through one of the "gas outlets," they can see representations of the graphite core and reflector, a boron sandwich shield above the core, control rods and gas sampling tubes for the burst cartridge detectors. The model is of a reactor similar in design to the two that are being erected for the South of Scotland Electricity Board's 320MW station at Hunterston, Ayrshire, and shows the double-shelled construction that has been adopted for the pressure vessels there. Among the other exhibits are the following.

Impermeable Graphite.—Graphite impermeable to gas and resistant to gaseous corrosion is demonstrated in the form of a tube filled with carbon dioxide at a temperature between 500 deg. and 600 deg. Cent. and a pressure of 10 atmospheres. The reddening of the hot graphite can just be seen. The space around the outside of the tube is evacuated and the rate of flow through the pump is monitored. Gauges show the internal and external pressures. The G.E.C. research laboratories have followed two lines in their quest for low-permeability graphite. One involved impregnation, and a millionfold improvement in the permeability of existing graphites has been found to be possible by this means. The other has resulted in the totally impermeable material shown at the exhibition. To produce this it was necessary to make the graphite in what is described as an entirely novel fashion. The product is said to behave like a metal, and gas has no access to the interior. Such material is potentially useful for sheathing fuel elements and for moderating reactors cooled by liquid metals.

Powered Manipulator.—A powered manipulator for radioactive and toxic materials is demonstrated in operation. It is remotely controlled, with no mechanical linkage between the control console and the arm, so it can be used to handle materials at a considerable distance and, if necessary, in conjunction with closed-circuit television.

High-Temperature Gas-Cooled Critical Assembly.—An illuminated schematic diagram shows the layout of a high-temperature, gas-cooled, zero-energy, critical assembly, which is being built for the U.K.A.E.A. at Winfrith Heath. It is thought that the temperatures attained may be high enough for gas turbines to be run from reactors of this kind.

Nuclear Power Plant Company, Ltd.

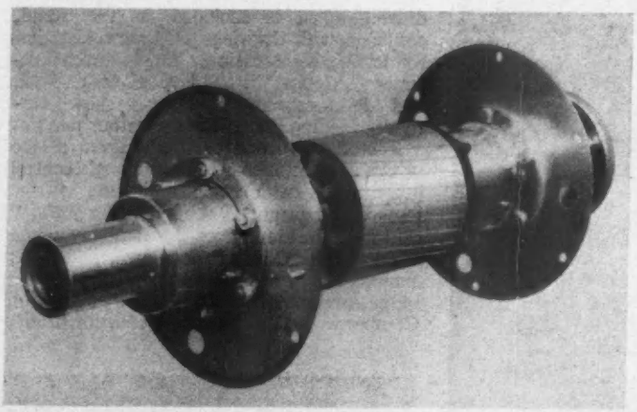
Five models are shown, one of a two-reactor, 400MW power station. The exhibiting company is responsible for the 300MW power station now well advanced in construction at Bradwell, Essex, the second undertaking of this kind to be started for the C.E.G.B. A number of photographs illustrates progress at the site, and the company's film "Bradwell," which recently gained a prize in Rome, is frequently shown. The remaining four models are of a 100MW turbo-alternator of the sort designed for nuclear power stations (C. A. Parsons and Co., Ltd.), the Brunswick Wharf steam-raising plant (Clarke, Chapman and Co., Ltd.), switchgear equipment (A. Reyrolle and Co., Ltd.), a "Counterflo" induced draught cooling tower and a Bradwell boiler (Head, Wrightson and Co., Ltd.). Strachan and Henshaw, Ltd., shows an animated fuel element grab, and Whessoe, Ltd., displays a typical weld section for a reactor pressure vessel. Sir Robert McAlpine and Sons, Ltd., portrays techniques used in the construction of reactor buildings. A model of a ship is exhibited by Swan, Hunter and Wigham Richardson, Ltd.; this firm recently agreed to collaborate with the N.P.P.C. in work on marine nuclear power.

U.K.A.E.A.

The practical aspects of nuclear reactors, instruments and materials are emphasised on the Authority's stand. Particular attention is drawn to the fuel element service for countries importing British reactors, and to the development in isotope production and sales. These subjects are presented through the media of films with multilingual sound tracks (English, French, German and Italian), animated diagrams, models, photographs and actual specimens. In the fuel element section is a display of examples ranging from the earliest to the latest types. Also demonstrated in this section is the train of events from the treatment of the raw material to the reprocessing of irradiated fuel elements.

Vickers Nuclear Engineering, Ltd.

The companies forming this consortium are Vickers, Ltd., Foster Wheeler, Ltd., and Rolls-Royce, Ltd. The interest here is in developing reactors for propulsion and for 15MW to 50MW power stations. The group was awarded the contracts for the building of a pressurised water prototype reactor and machinery for submarine use, leading to the projected H.M.S. "Dreadnought." This project is still being pursued, although it will be modified in the light of what is learnt from American practice under the recent agreement for the exchange of information in this field. The consortium has built, and is operating with the U.K.A.E.A., the research reactors "Lido" and "Neptune," both of the "swimming-pool" variety, and has also made a number of radioactive and inactive loops for use in research on heat transfer, corrosion, nuclear physics, &c., and both water and liquid metallic coolants have been investigated. A model of "Lido" is shown, together with photographs of the original at Harwell, and there are also models of an advanced gas-cooled reactor in a "super-tanker" and a pressurised water reactor in a "large" tanker.



Rotating assembly of a gas circulator made by the de Havilland Engine Company, Ltd., for use in loops. Gas bearings are located in the diaphragms. End load is taken on a gas bearing universally mounted on gimbals

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We have described above, very briefly, the stands of the major consortia of the British nuclear power industry. These more or less highly integrated concerns are by no means the only undertakings interested in atomic energy in the United Kingdom, and we select for notice below some of the other companies exhibiting in the British section at Geneva.

De Havilland Engine Company, Ltd.

This company's investigations have led it to the conclusion that high-temperature gas-cooled reactors using ceramic fuel elements could be designed to be competitive with conventional prime movers for the generation of 10MW to 30MW of electrical power. Participation in the development of this type of reactor has been chosen as one of the firm's principal objectives in the nuclear field. A loop designed and built in collaboration with the A.E.R.E. is to be used for testing new ceramic fuel elements in "Pluto" at Harwell. A primary coolant temperature as high as 800 deg. Cent. is regarded as entirely feasible, and it is thought that the use of gas turbines may well become possible. Certain equipment developed by the company is now being offered commercially. A typical example is a small high-speed gas circulator with gas bearings that need no maintenance.

Ekco Electronics, Ltd.

A reactor control panel is used to display typical examples from the Ekco range of instruments. The panel represents part of the control room of a heavy-water-moderated research reactor such as "Pluto," the Dounreay material testing reactor, "Hifar" or the Danish D.R.3. The instruments shown include three new transistorised units designed to minimise maintenance.

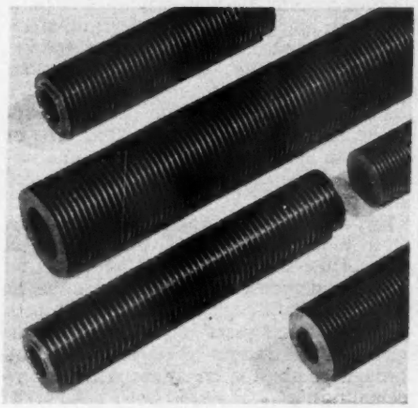
Elliott Brothers (London), Ltd.

This company also shows a panel carrying instruments and equipment for the control of nuclear plant. Working demonstrations are given of a reactor simulator of a kind intended mainly for instruction. It takes the form of a typical reactor control desk, with all the controls and indicators found in a real case. Standard Elliott analogue computing units are used. The outputs from the units represent reactor power, reactor period, shut-off rod and control rod positions, reactivity, &c. The simulator permits either manual or automatic control. Automatic regulation is by either an on-off or a proportional controller. Power-level and period trips are incorporated.

Imperial Chemical Industries, Ltd.

Simple products in beryllium, vanadium and niobium are shown. A display of wrought titanium and zirconium products includes an ingot of titanium made in the latest I.C.I. vacuum-melting plant and weighing nearly 2

tons. This is stated to be the largest yet made in Europe. Zirconium supports for fuel elements, of the kind that will be used at Berkeley power station, are exhibited. I.C.I. Metals Division has been associated since 1943 with the design and manufacture of fuel cans. To-day, the Division supplies



"Integron" high-fin tubing in steel as specified for the heat exchangers of Berkeley and Bradwell nuclear power stations

aluminium or "Magnox" cans with longitudinal or helical fins made by extrusion or rolling. A number of cans is shown, including a 12ft length of zirconium can made for A.B. Atomenergi in connection with the Swedish atomic development programme. Examples of "Integron" finned tube for heat exchangers are also shown. It is stated that nearly 400 miles of a special form of steel "Integron" tube is being used for the heat exchangers of Berkeley and Bradwell power stations. Other exhibits include such fabricated components as light alloy pipework, heat exchangers, a tube bundle for connecting a burst slug detector to the inside of a reactor, and a plate fuel element for a British research reactor.

Mitchell Engineering, Ltd.

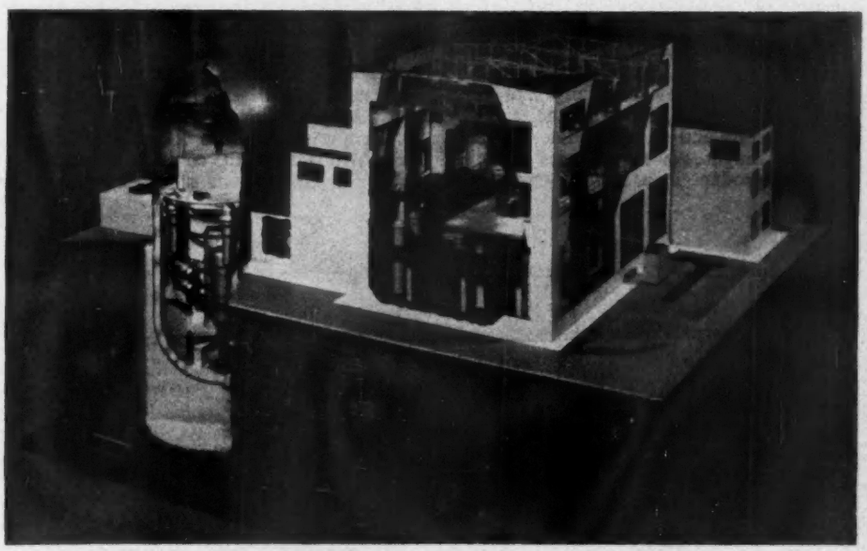
A scale model of a closed-cycle boiling water reactor putting out 17·5MW of electrical power forms the centre piece of this company's stand. Ordinary water moderates and cools the reactor, and the fuel consists of uranium dioxide pellets clad in stainless steel. The core is 5ft in diameter and 5ft high and is made of 164 fuel assemblies. The fuel is enriched to 3 per cent in U^{235}. There are thirteen cruciform control rods. The reactor puts out 58·5MW of heat and operates at 900 lb per square inch. The steam conditions for the turbine are 600 lb per square inch and 489 deg. Fah. Mitchell Engineering, Ltd., is a main contractor for stations of 17·5MW to 140MW electrical output, in association with the American Machine and Foundry Company of New York.

Mullard Equipment, Ltd.

A new system of reactor safety equipment, which the company claims is more reliable than systems now in use, here makes its first public appearance. Equipment of this kind is soon to be installed for field trials at Dounreay. The enhanced reliability is said to be due to the replacement of conventional electro-mechanical relays by transistor logic circuits, and to the use of printed circuits. The system warns the operators of a reactor, or shuts the latter down, if fault signals are received from certain monitors. It distinguishes between fault signals due to failure of a monitoring channel and those due to a genuine abnormality in the reactor. Normally the monitoring channels feed a steady signal to the system; this signal ceases when an abnormality appears. Monitoring channels may be set to trip when the measured parameter makes its greatest permitted excursion, and shut down the reactor, or they may merely give a warning. Channels in the former class are grouped in threes, each group providing three independent measurements of the same parameter. Shutting down action is only initiated if fault signals are received from at least two of the channels in a trio. The system can be matched to any kind of reactor.

The 100-channel pulse analyser ("kick-sorter") is also shown here for the first time. Used with a proportional detector and a standard pulse amplifier it will analyse the energy spectra of nuclear radiations. It can be used for research, identification of radioactive substances, and, in conjunction with neutron time-of-flight apparatus, the measurement of nuclear cross sections. The pulse spectrometer is based on an A.E.R.E. design. Pulses from a proportional detector are sorted and counted according to their relative amplitudes into one of the hundred channels, and then stored magnetically. Since each channel represents a particular energy level the information recorded provides a histogram. The information is presented on a 6in cathode ray tube as a continuous linear analogue display. Direct read-out of the number of counts in a channel is also available. This is non-destructive, and information is retained in the store until deliberately erased. Each channel can store 65,536 counts. The maximum counting rate is limited only by what fraction of counts may be lost due to the dead time. The latter is constant at 250 microseconds. The instrument operates from single-phase mains of 200V–250V, 45–65 c/s, and consumes 300W. The store is protected against mains failure, and the equipment is stabilised against variations in the mains voltage of up to ±10 per cent.

Also shown for the first time on the Mullard stand is an ultrasonic cleaner specifically for removing radioactive contamination.



A scale model of a closed cycle boiling water reactor with an electrical output of 17·5MW. This appears on the stand of Mitchell Engineering, Ltd.

List of British Exhibitors

The list of British exhibitors at the commercial exhibition is as follows: A.E.I.–John Thompson Nuclear Energy Company, Ltd.; Aiton and Co., Ltd.; A.P.V.–Paramount, Ltd.; Atomic Power Constructions, Ltd.; Avo, Ltd.; Babcock and Wilcox, Ltd.; British Thomson-Houston Company, Ltd.; Cambridge Instrument Company, Ltd.; Chance Pilkington Optical Works (Pilkington Brothers, Ltd.); Clarke, Chapman and Co., Ltd.; Cossor Instruments, Ltd.; Crompton Parkinson, Ltd.; Dawe Instruments, Ltd.; De Havilland Engine Company, Ltd.; Ekco Electronics, Ltd.; Electronic Instruments, Ltd.; Elliott Brothers (London), Ltd.; E.M.I. Electronics, Ltd.; English Electric–Babcock and Wilcox–Taylor Woodrow Atomic Power Group; English Electric Company, Ltd.; Evans Electroselenium, Ltd.; Fairey Aviation Company, Ltd.; Ferranti, Ltd.; Alex. Findlay and Co., Ltd.; Fleming Radio (Developments), Ltd.; Foster Wheeler, Ltd.; General Electric Company, Ltd.; G.E.C., Simon-Carves Atomic Energy Group; General Radiological, Ltd.; Hawker Siddeley John Brown Nuclear Construction, Ltd.; Hayward Tyler and Co., Ltd.; Head, Wrightson and Co., Ltd.; H. M. Hobson, Ltd.; Hutcheon Duthie and Son, Ltd.; Imperial Chemical Industries, Ltd.; International Combustion (Holdings), Ltd.; Isotope Developments, Ltd.; Isotope Division, A.E.R.E.; George Kent, Ltd.; Labgear, Ltd.; Sir Robert McAlpine and Sons, Ltd.; Metropolitan-Vickers Electrical Company, Ltd.; Mitchell Engineering, Ltd.; Mond Nickel Company, Ltd.; Mullard Equipment, Ltd.; Nash and Thompson, Ltd.; Negretti and Zambra, Ltd.; Newman, Hender and Co., Ltd.; Nuclear Civil Constructors; "Nuclear Engineering"; Nuclear Engineering, Ltd.; Nuclear Enterprises (G.B.), Ltd.; Nuclear Graphite, Ltd.; "Nuclear Power"; Nuclear Power Plant Company, Ltd.; C. A. Parsons and Co., Ltd.; Pergamon Press, Ltd.; Plessey Nucleonics, Ltd.; Pye Instrument Group; Radiochemical Centre; A. Reyrolle and Co., Ltd.; Richardsons, Westgarth and Co., Ltd.; The Rio Tinto Company, Ltd.; Rolls-Royce, Ltd.; Saunders-Roe, Ltd.; Savage and Parsons, Ltd.; Shell Petroleum Company, Ltd.; Simon-Carves, Ltd.; The Sperry Gyroscope Company, Ltd.; The Solartron Electronic Group, Ltd.; Stanton Instruments, Ltd.; R. A. Stephen and Co., Ltd.; Strachan and Henshaw, Ltd.; Sunvic Controls, Ltd.; Taylor, Taylor and Hobson, Ltd.; Taylor Woodrow Construction Company, Ltd.; John Thompson, Ltd.; T.I. Nuclear Engineering, Ltd.; Townson and Mercer, Ltd.; Twentieth Century Electronics, Ltd.; U.K. Atomic Energy Authority; Vickers Nuclear Engineering, Ltd.; Vickers-Armstrongs, Ltd.; Vokes, Ltd.; Whessoe, Ltd.

International Institution of Production Engineering Research

The eighth general assembly of the International Institution for Production Engineering Research is being held in this country from September 1 to September 8 next, and it will be attended by representatives from fourteen countries. This institution was formed in 1949–50 by four founder members—Dr. D. F. Galloway, Director of Research of the Production Engineering Research Association (Great Britain); Ingenieur General Nicoleau, Director of the I.S.N.C.M. (France); Professor Bickel, of the Ecole Polytechnique federale de Zurich (Switzerland); Professor Peters of the Universite de Louvain (Belgium). The object of these founder-members was to establish a common meeting ground on which scientists in the field of production technology could discuss problems freely in an atmosphere of mutual trust and confidence. One of its main objectives is the removal of barriers to effective communication between production scientists, consistent with national security.

Scientific sessions of the institution are restricted to members and they will take place this year in London, Leamington Spa, Melton Mowbray and Buxton. Formal receptions have been arranged by a number of firms and tours will be made of the works of A.E.C., Ltd., and the Standard Motor Company, Ltd.

Brown Coal Burning Gas Turbines

A PRELIMINARY EXAMINATION OF OPERATIONAL PROBLEMS

By J. C. WISDOM, M.Mech.E., A.M.I.E. (Aust.)*

The Commonwealth Government's Aeronautical Research Laboratories in Melbourne, which have been working for some years on the problem of applying indigenous fuels to the gas turbine, now believe that a successful method has been found of utilising Victorian brown coal as a turbine fuel. Until now the critical problem associated with the use of coal as a turbine fuel has been the damaging effects on the turbine blades of erosion, corrosion and deposition arising from impurities in the coal—a problem which either does not arise or is negligible when petroleum distillate fuels are used to fire the gas turbine. The A.R.L. research group has developed a prototype combustion chamber which has proved so successful that it is now possible to advance experiments from laboratory and bench scale to the stage involving the experimental operation of an engine on a commercial scale. For this purpose, a 1200 h.p. gas turbine is at present being installed at the laboratories. After calibration on distillate fuel, the engine will be subjected to tests with the newly-designed combustor, using Victorian brown coal. These tests should commence towards the end of this year.

A RUSTON AND HORNSBY type "TA" gas turbine is scheduled to commence experimental operation on Victorian brown coal at the Aeronautical Research Laboratories towards the end of 1958. This project follows nine years of preliminary research and development work on test rigs in assessing the problem of utilising brown coal as a possible gas turbine fuel.

Very large deposits of sub-bituminous coal, amounting to some 38,000 million tons, exist in Australia, mostly in the State of Victoria, in the form of brown coal ; having regard to the relatively small population which is likely to consume these resources, this fuel reserve is likely to last some hundreds of years. While this natural asset is being vigorously exploited for the production of electric power using steam turbines, gas production and briquette production, the proportion of the nation's total energy consumption provided by brown coal remains substantially constant. Table I[1] shows the trend of fuel usage in Australia, where it is seen that the locally available energy resources are losing ground compared with imported liquid fuels.

TABLE I—*Percentage of Total Energy Consumed*

Year	Petroleum products	Wood	Black coal	Brown coal	Hydro-electric power
1945–6	18·3	19·7	53·3	6·7	2·0
1955–6	29·4	11·2	47·9	7·6	3·9

A similar situation exists in many countries of the world and, no doubt, in each case, arguments have been raised questioning the wisdom of basing a nation's economy too heavily on imported fuels, whose origin is insecure.

While it is obviously not feasible to render all energy producers independent of imported fuels, there is, nevertheless, scope for reintroduction of solid fuel usage provided that suitable and economical methods can be devised. The gas turbine, with its potential ability to burn solid fuels and produce both power and heat in useful forms, is one vehicle by which the more efficient use of coal could be fostered.

Relevant Properties of Brown Coal

In many respects Victorian brown coal is an attractive solid fuel for gas turbines, providing that a method of reducing its naturally high moisture content of 65 per cent is available. There is an expanding briquetting industry where fuel is dried to about 15 per cent moisture content before it is processed and transported to centres of usage. In its dried condition, Yallourn brown coal has the following typical proximate analysis.

Moisture	15·0 per cent
Volatiles	43·0 per cent
Fixed carbon	40·3 per cent
Ash	1·7 per cent

This analysis indicates that there should be little difficulty in securing efficient high heat release combustion in view of the high volatile content of the coal ; this view would be reinforced by a further favourable property of brown coal, namely, its extreme friability which allows it to be pulverised in conventional hammer mills such that 95 per cent passes a 300 mesh B.S.S. sieve. This is really an unsatisfactory method of expressing the fineness of the milled product, since size analysis by air elutriation methods shows that over 60 per cent of the product is less than 10 micron in size and the remainder consists of aggregations of these small particles in sizes ranging up to 50 microns.

Whilst greatly assisting the combustion process, this extreme fineness causes considerable difficulty in the handling and even metering of the fuel, owing to the tendency to agglomerate and to consolidate ; experience has taught the laboratories never to store the product in a hopper, even for a few minutes, since packing and arching always follow.

The low ash content of Yallourn brown coal is a favourable property, especially as it is allied with a high fusion-temperature under oxidising conditions of 1400 deg. Cent.

Combustor Design

It has been found entirely feasible to burn brown coal in a straight-through all-metal combustor, based on aircraft gas turbine principles, without any ash accretion. Although it is the main purpose of this article to discuss the ash problem with respect to the turbine blades, it may be of interest to indicate the combustor configuration which is planned for the Ruston and Hornsby turbine.

Fig. 1 shows a drawing of the combustor, which it is intended to fit to the engine in place of the standard oil-burning unit, after it has undergone rig tests at atmospheric pressure. The design of this unit has been based on some years' experience with the operation of various designs of straight-through combustor on atmospheric experimental rigs.

The configuration of the outer casing is, of course, determined by engine requirements, and is basically a simple, straight-through design with side air entry. The flame-tube is fabricated of 18 : 8 stainless steel and is perforated in the region of primary combustion to admit cooling air to the walls. With the pressure drop normally available for admitting combustion air, the air velocity through the perforations is too high to secure a stagnant zone of cool air against the inner flame tube surface ; this head is reduced by a muff which encloses this perforated section, with a metering annulus at entry. This cooling system has been found effective and, in a test combustor, flame tube temperatures of about 600 deg. Cent. were found at a flame zone temperature of about 1400 deg. Cent. A 4 : 1 coal-air mixture is injected into a premixing pipe terminating in a swirler at the apex of the inlet cone of the flame tube ; combustion air enters through swirl vanes, concentric with the coal nozzle, and through annular slots in the entry cone and at the junction with the cylindrical section. Atmospheric tests of a smaller scale unit showed an efficiency of 94 per cent based on a temperature traverse of the exhaust ; the heat release rate was 1,000,000 B.Th.U. per cubic foot per hour and the pressure drop 0·1 lb per square inch. Preliminary experiments with a half-scale version of this model at a pressure of 2 atmospheres indicate that much higher efficiencies can be achieved under constant air velocity conditions.

The low temperature of operation of the air-cooled walls of the combustor, combined with low ash content of the coal and its

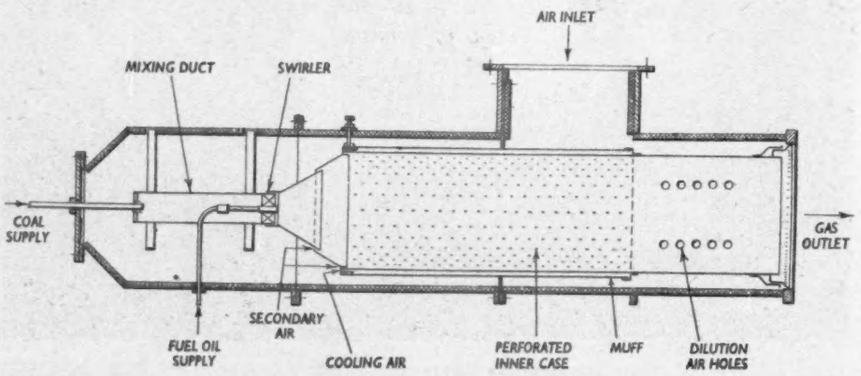
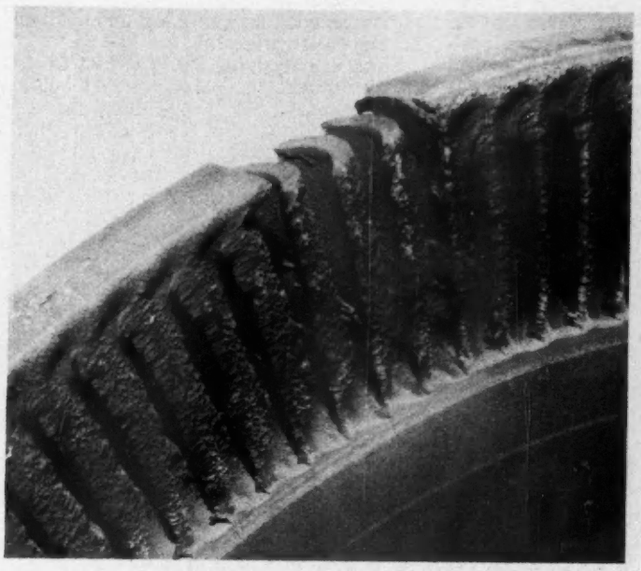
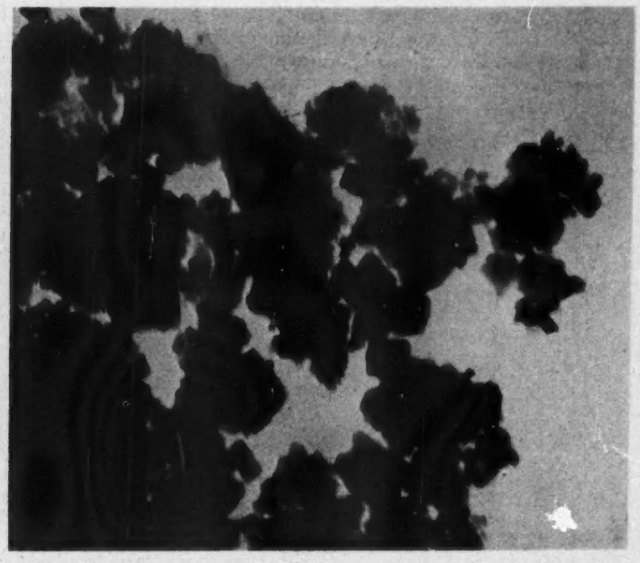


Fig. 1—Combustor for R and H gas engine

* The author is a Principal Scientific Officer in the Aeronautical Research Laboratories of the Australian Department of Supply.





Figs. 2 and 3—(Left) Brown coal ash deposition without control ; sixty hours' operation at 650 deg. Cent. turbine inlet temperature. (Right) Structure of sintered ash deposit ; magnification ×13,500

chemical composition, resulted in freedom from ash fouling of the walls during the periods of operation on test rigs.

The Ash Problem with Respect to the Turbine

The size distribution of the coal ash in the combustion gases determines the nature of the ash problem, and the type of gas turbine cycle which is best suited to the fuel. The composition of brown coal ash and its distribution in the general coal structure is somewhat different from that encountered with higher rank coals. The composition of the ash is generally low in mineral matter originally deposited as sediment (silica and alumina), and high in compounds derived from solution in water. The capillary structure of the coal, in which the aqueous solution was originally held, ensures that the ash is uniformly divided throughout the coal and aggregations are avoided. It could be assumed that ash particles from combustion of finely divided coal would be extremely small, and this was confirmed when samples of the exhaust gases were taken and analysed. An electron micrograph of the sample showed that the majority of ash particles were less than 1/30th micron in size. There seemed, therefore, to be little likelihood of erosion of turbine blades if brown coal were used in a direct fired open cycle ; nor would there be any possibility of effective ash removal from the working fluid.

Experimental running with a small impulse turbine wheel indicated the magnitude of the ash problem. Fig. 2 shows the result of a sixty-hour run with a turbine inlet temperature of 650 deg. Cent.; deposition of ash occurred at a high rate and the usual pattern of build up was observed, hard sintered ash on the leading edge and convex face with a soft powdery deposit in the region of airflow separation. An electron micrograph (Fig. 3) of the sintered product indicates an aggregation of unfused particles apparently held together by a bonding agent ; it was obviously desirable to discover the nature of this compound if an effective chemical method of controlling it were to be found.

Experiments were put in hand to correlate rate of deposition with chemical composition of the coal ash ; this was achieved by subjecting suitably dried and pulverised brown coal samples from five different regions in Victoria to a standardised deposition test. This consisted of measuring the increase in weight of a stainless steel tube placed in the exhaust stream of a coal-burning combustor, the pattern of deposition on the cylinder simulating that on a turbine blade. Table II shows the ash chemical analyses of the five coals, and Table III the result of the deposition tests. The important results are that the heaviest deposit from Morwell coal is fifty-six times greater than from Maddingley coal and that the only components which are present in the ash in significantly greater proportion in the former are SiO_2, Na_2O and Cl. The influence of SiO_2 is not considered important and attention was, therefore, directed to Na and Cl.

The importance of these two elements was highlighted by a further series of experiments with samples of Morwell and Maddingley coal with subtractions and additions of sodium chloride. Morwell coal was washed for forty-three hours to remove 80 per cent of the water soluble ash constituents and to Maddingley coal was added 0·5 per cent, by weight, of sodium chloride. Table IV shows the results, where it can be seen that

Table II—*Analysis of Brown Coals in Comparative Ash Deposition Experiments*

Source of sample	Morwell	Wensleydale	Yallourn	Yallourn North	Maddingley
	Per cent	Per cent	Per cent	Per cent	Per cent
Coal as tested :					
Moisture	15·1	14·1	15·5	19·7	10·1
Ash	3·2	3·1	1·5	3·5	8·3
Volatiles	43·4	41·4	43·5	40·7	44·2
Fixed carbon	38·4	41·4	39·5	36·1	37·4
Ash analysis :					
SiO_2	23·25	11·95	9·50	10·82	11·34
Fe_2O_3	7·61	12·36	33·54	31·46	8·46
Al_2O_3	7·20	15·24	5·37	4·30	14·32
TiO_2	0·72	0·64	0·60	0·67	0·64
CaO	12·31	14·60	11·36	28·32	21·72
MgO	19·25	14·57	17·88	9·93	13·2o
K_2O	0·73	0·80	0·87	0·60	0·58
Na_2O	10·23	4·12	4·10	0·82	2·31
SO_3	16·25	26·80	16·53	12·20	29·63
P_2O_5	0·06	0·07	0·05	0·12	0·25
Cl	1·11	0·06	0·09	0·20	0·08

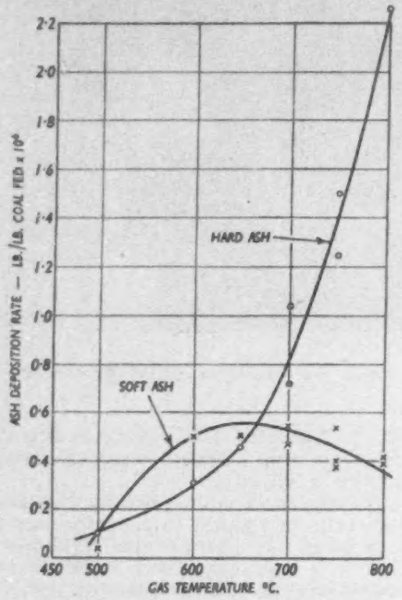
Table III—*Comparative Ash Deposition Tests—Combustion Gas Temperature 700 deg. Cent.*

Source of coal	Morwell	Wensleydale	Yallourn	Yallourn North	Maddingley
Weight of coal used (pounds)	300	327	429	255	195
Weight of ash passed (pounds)	9·6	10·1	6·4	8·9	16·0
Weight of hard deposit $\frac{\text{lb} \times 10\text{–}4}{\text{lb ash fed}}$	2·10	0·0727	0·570	0·143	0·0375
Weight of soft deposit $\frac{\text{lb} \times 10\text{–}4}{\text{lb ash fed}}$	0·477	0·0993	0·1458	0·1171	0·0882

Table IV—*Effect of Addition and Subtraction of Sodium Chloride*

	Maddingley coal				Morwell coal			
Nature of coal	Untreated		Treated		Unwashed		Washed	
Moisture content (per cent) (as fed)	16·0	16·8	22·0	16·0	17·8	15·0	17·0	12·25
Ash content (per cent) (as fed)	7·16	6·50	6·10	6·60	3·10	3·20	2·97	2·39
Weight of coal fed (pounds) (corrected to 15 per cent M.C.)	221·0	225·0	225·0	237·0	251·0	270·0	288·0	223·0
Weight of ash fed (pounds) (corrected to 15 per cent M.C.)	16·02	16·50	14·90	15·70	8·03	8·82	8·38	5·17
Weight of hard deposit : $\frac{\text{(Pounds} \times 10\text{–}4)}{\text{(Pounds ash fed)}}$	0·426	0·380	1·576	2·627	1·490	1·795	0·163	0·269
Average ratio $\frac{\text{treated}}{\text{Untreated}}$	5·22				1/7·58			

significant changes took place in rate of ash deposition. These experiments confirm the hypothesis that the deposit is formed by the cementing together of refractory compounds, which form the bulk of the deposit, with a very small proportion of a constituent which can become sticky at operating temperatures encountered in gas turbine practice. Owing to the extremely small amounts of bonding agent operating, it is difficult to determine its exact composition by chemical or spectrographic means; the question of whether chlorides or sulphates in combination with alkali metals are important to the process, or whether it is their interaction as suggested by Sulzer,[2] has yet to be determined.



Gas velocity 350ft per second; Yallourn brown coal, 15 per cent moisture.

Fig. 4—Effect of gas temperature on ash deposition

Methods of Controlling Deposition

An investigation of the various factors contributing to the rate of deposition of brown coal ash has led to the evolution of various possible methods of control.

Temperature Control.—The most important factor affecting rate of deposition on turbine blades is gas temperature, and Fig. 4, prepared from the results of the standard deposition test, shows that the deposition of hard sintered ash increased by a factor of fifteen between gas temperatures of 500 deg. and 800 deg. Cent. It would appear that the turbine inlet temperature of a brown coal-burning gas turbine would have to be limited to about 650 deg. Cent., but actual engine operational data must be awaited before this point can be resolved.

Erosion Control.—A possible method of controlling ash deposits is suggested from experiments with cyclone type ash separators. Although it has been shown that the bulk of the ash leaving the combustor is extremely fine, there is, nevertheless, a certain small concentration of aggregates, which form in the combustor and become detached. It was found, contrary to expectation, that the rate of deposition on a standard specimen rose by 70 per cent when the separator was fitted; it was considered that the removal of the coarser particles had upset a balance between deposition of the finer particles and erosion of this deposit by coarse particles.

This suggested that the deliberate addition of relatively large particles could increase the erosive action to a stage where deposition could be reduced to small proportions, possibly without actual damage to the turbine blades. To test this hypothesis, the coal ash size distribution was modified by adding to the coal entering the pulveriser a quantity of sand of 60 micron mean size. The result, shown in Fig. 5, was that the rate of deposition of hard ash decreased with addition of sand until actual erosion of the metal specimen took place.

Some turbine tests were then carried out with the sand injected into the turbine casing in the ratio of 2 per cent of the coal flow. The results were encouraging, and Fig. 6 shows the results of running the engine for twenty hours at a turbine inlet temperature of 650 deg. Cent. Virtually no ash had deposited on the blades and close inspection failed to indicate any sign of erosion. Attempts to remove ash already deposited by intermittent injection were unsuccessful; the low gas velocity, relative to the moving turbine blades, compared with more normal turbine practice, may have had an important bearing on the process.

Since velocity is obviously critical to the erosion process, this effect was also studied in the standard rig. Fig. 7 shows that the natural rate of sintered ash deposition decreased by a factor of four as the approach gas velocity to the specimen increased from 200ft to 640ft per second; extrapolation indicates that zero deposition rate might occur at a gas velocity of about 800ft per second, which is the order of the velocity of the gas relative to the first row of moving blades in an industrial gas turbine.

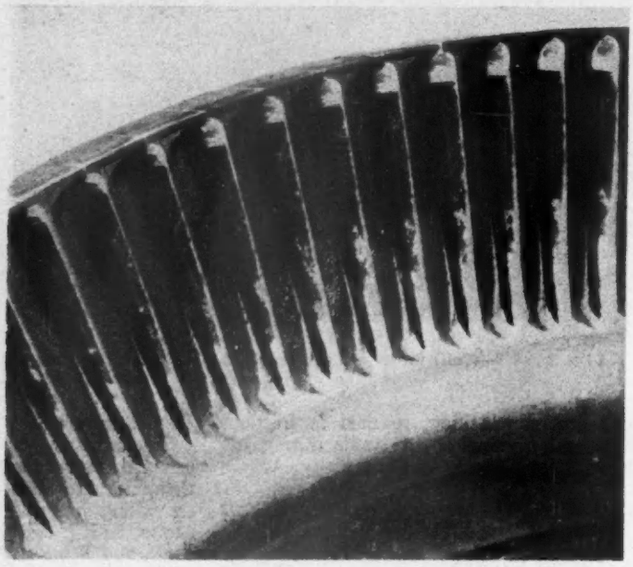
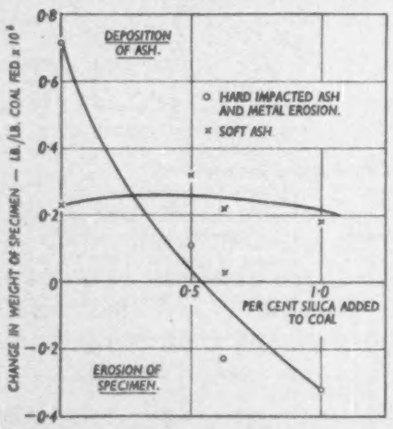


Fig. 6—Ash deposition with continuous injection of sand particles

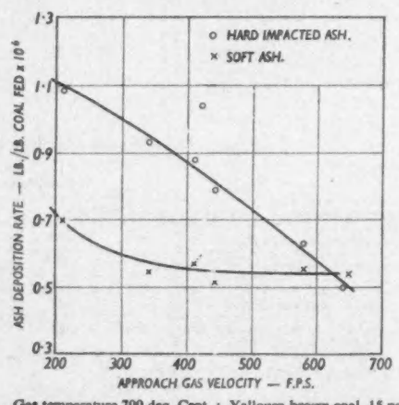
Absorption of Bonding Agent.—It has been reported[3] that deposits on tubes of certain pulverised-fuel-fired boilers tended to decrease when coals having higher ash concentrations were used; this suggests that a high ash loading may cause absorption or dilution of volatilised and sticky ash compounds and so reduce the bonding effect.

Conditions of increased dust loading were simulated in the coal-burning combustor by adding to the coal varying quantities of kaolin, milled such that nominally 100 per cent was less than 10 micron in size. It was found in practice, however, that 54 per cent



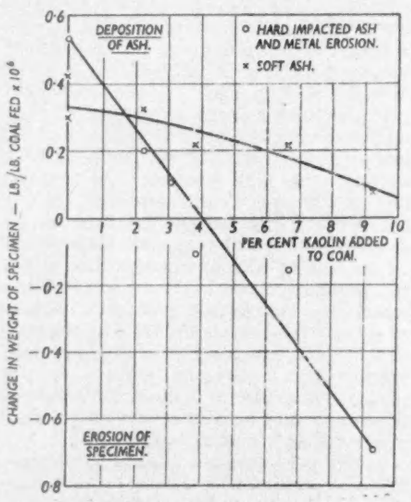
Gas temperature 700 deg. Cent.; gas approach velocity 350ft per second; Yallourn brown coal 15 per cent moisture.

Fig. 5—Effect of fine sand addition on ash deposition rate



Gas temperature 700 deg. Cent.; Yallourn brown coal 15 per cent moisture.

Fig. 7—Effect of increasing approach gas velocity on ash deposition rate



Gas temperature 700 deg. Cent.; gas approach velocity 570 per second; Yallourn brown coal 15 per cent moisture.

Fig. 8—Effect of kaolin addition on ash deposition rate

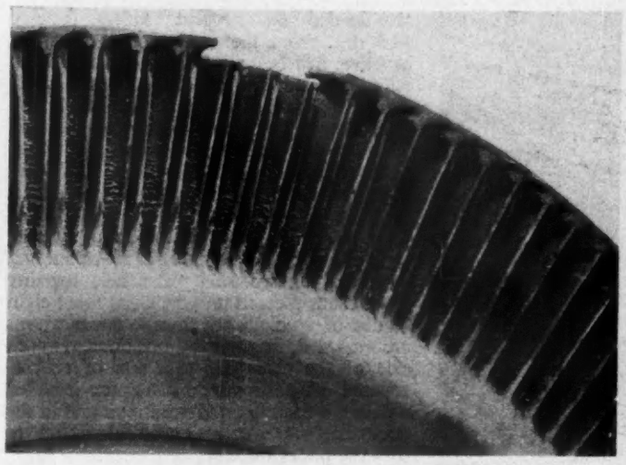


Fig. 9—Ash deposition with continuous water injection

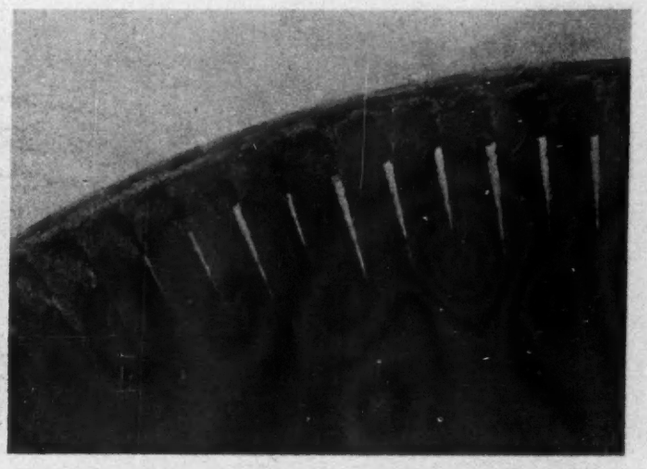


Fig. 10—Removal of ash deposit after water quenching treatment

of the product had agglomerated to greater than 56 micron and the presence of particles of this size in the gases passing the test specimen could result in an increased erosion effect. Fig. 8 shows that erosion of the metal specimen did, in fact, occur when the kaolin addition was greater than 4 per cent of the coal ; at the same time, however, the rate of deposition of the soft ash in the region of air flow separation behind the cylindrical specimen showed a marked drop as kaolin was added. Since this could not be explained in terms of increased erosion it could be concluded that some measure of inhibition of the bonding action had taken place. It is likely, therefore, that the onset of metal erosion was hastened by an accompanying decrease in natural deposition. In any case, it is possible that controlled addition of a finely divided and a chemically inert compound could cause a significant reduction in the deposition of brown coal ash in a gas turbine.

Water Injection.—The injection of water to quench the sticky ash constituents and so reduce deposition, has been advanced as a possible control method. It has been demonstrated in turbine cooling experiments that it is possible to maintain a liquid film on a turbine blade for a significant time, despite the high temperature. Turbine tests with water injected into the casing at a rate of 2 per cent of the airflow showed that the rate of hard ash deposition was reduced by a factor of four with no change in the deposition of soft ash. Fig. 9 shows a view of the turbine after fifty hours' operation.

An alternative technique is the injection of large quantities of water at intervals to quench the hot blade deposits and, possibly, to remove them by spalling or flaking. This method was tried with a turbine which had accumulated deposits after twenty hours of running ; ¾ gallon was injected during three minutes as the fuel supply was switched off. Fig. 10 shows the favourable effect on the ash, and measurements showed that half the deposit on the rotor had been removed.

Conclusions

On the basis of the preliminary experiments reported above it is believed that the operation of the full-scale industrial gas turbine on pulverised brown coal will not be attended by any insurmountable difficulties. It is planned to operate the engine initially with a maximum turbine inlet temperature of 650 deg. Cent., and it would be expected that ash fouling problems will be confined to the first stator and rotor stage. The combination of high temperature and relatively low gas velocity approaching the stator blades will lead to deposition of ash, and it is hoped that the main instrument of control will be intermittent water injection to remove the deposit by heat shock. Should this prove inadequate it will be necessary to add to the coal controlled quantities of kaolin or some other finely milled refractory compound which has been shown to inhibit the bonding action of the low melting point compounds in the ash. Alternatively, this additive could be milled to such a size that it would provide a controlled measure of erosion of the deposit.

The established temperature deposition characteristic of brown coal ash would indicate that build-up of a sintered deposit would be very small on the blades of the power turbine, where an inlet temperature of about 500 deg. Cent. is expected. Nevertheless, some water washing will be necessary to remove the soft deposits which will form near the trailing edge of the blades even at low temperatures.

Acknowledgment

The experimental work, upon which this article is based, was carried out in the Aeronautical Research Laboratories, Australian Department of Supply, and the project is sponsored by the Department of National Development. The article is published with the permission of the Chief Scientist, Department of Supply.

References

[1] Table compiled from information supplied by the Department of National Development, Commonwealth of Australia.
[2] P. T. Sulzer, *Transactions of the American Society of Mechanical Engineers*, October, 1955. "The Influence of Some Chemical and Physical Factors on the Formation of Deposits from Residual Fuel."
[3] P. J. Jackson and W. M. Ward, *Journal of the Institute of Fuel*, April, 1956. "Operational Studies of the Relationship Between Coal Constituents and Boiler Fouling."

Shot Blasting of Plates and Sections

Corrosion of ship's plates involves high maintenance charges, and an important factor in its prevention is the durability of the paint film which depends largely upon the plate surface being free from millscale. For the complete removal of the millscale and the production of a uniform and suitably etched surface Tilghman's, Ltd., has developed shot blasting equipment for both plates and sections.

THE reduction of the life of plates due to corrosion and the heavy cost in repairs and maintenance involved have been major problems of the shipping industry for many years. Lloyd's Register of Shipping has long recognised this problem of corrosion, and it is of interest that as long ago as 1888 one of the measures for preventing corrosion, advocated in the Rules, was the complete removal of millscale prior to painting. Apart from other considerations the removal of paint is one of the commonest causes of corrosion so that maximum paint durability is a measure of the degree of prevention of corrosion. To secure this the paint has to be applied to a surface as free as possible from millscale and rust. Millscale is the result of iron oxidisation during the high temperature rolling process and it adheres with varying strength of bond so that any equipment designed for its removal must be capable of disintegrating both the brittle and the strongest bonded scale.

Tilghman's, Ltd., at the request of an oil tanker company, has been investigating the possibilities of employing shot blasting for both the removal of millscale and the production of a uniform surface etched to a degree sufficient to ensure a permanent bond between metal and its coating. Extensive trials were carried out and sample plates were built into a ship in which half the plates were shot blasted while the remainder were used in the condition as supplied from the mills. After six months sea service the ship's plating was examined and the condition of the shot blasted plates was such that the company decided that all the plates used for building the company's ships should be treated by shot blasting. Further work has been done and as a result of investigating the effect of the depth of indentation, obtained by using different grades of shot, it was concluded that keeping the indentations to a minimum, consistent with the removal of scale, gave the best results, since this reduced the quantity and the film thickness of the paint required. Questions concerning the speed of travel of the component were investigated together with methods of handling, drying and protection after shot blasting and from the data collected Tilghman's, Ltd.,

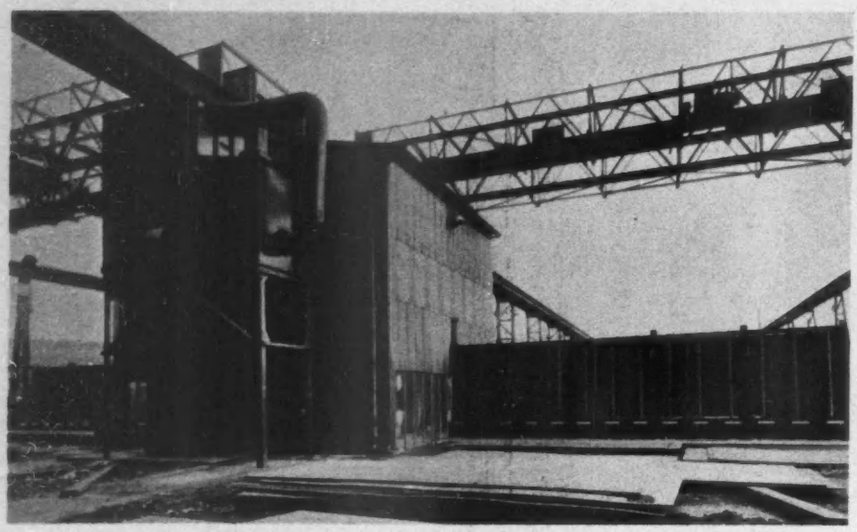
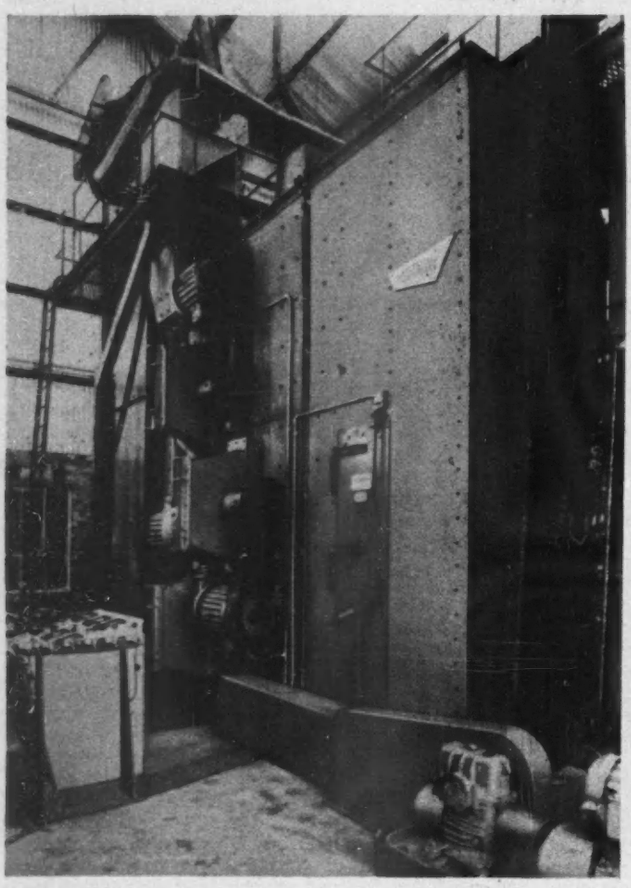


Plate cleaning installation at Smith's Dock Company, Ltd., showing a plate entering the plant on the conveyor and the dust collector

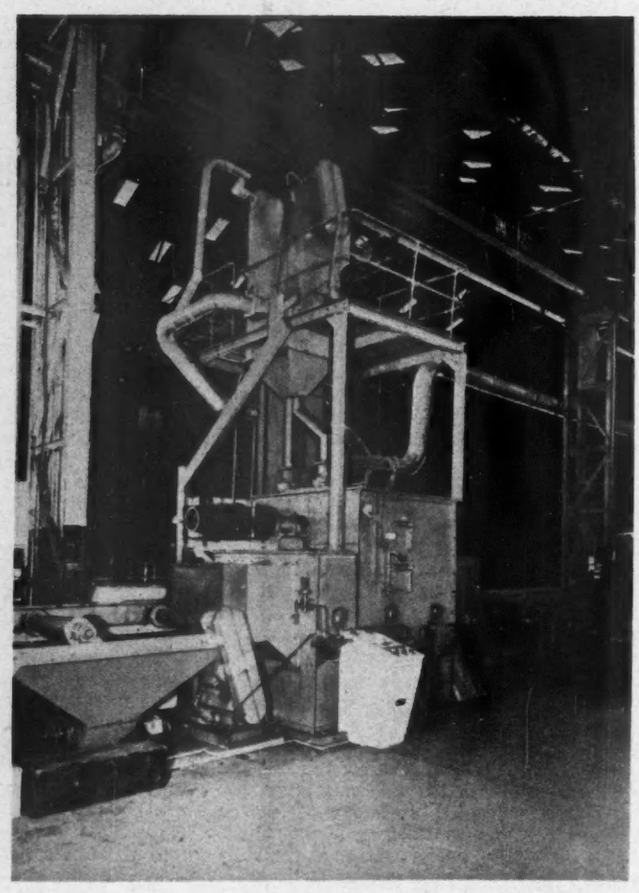
has designed a range of machines suitable for installation in both small and large shipyards. This range includes machines having four, six or eight centrifugal shot-projection units and, in addition, a plant with a single or dual wheel unit incorporating the means to increase the blast width. Thus one wheel covers a width of about 6ft at one pass to meet the requirement of builders using small plates and having a relatively small production: the speed of throughput is reduced to compensate for the oscillating movement of the blast pattern.

The first Tilghman's airless shot blasting installations have been put into operation at Smiths Dock Company, Ltd., South Bank, Middlesbrough, and at the Northsands yard of J. L. Thompson and Sons, Ltd., Sunderland. The plant, illustrated herewith, has six shot projection units dispersed and angled so as to provide adequate blast coverage over both sides of the plate. Plates are loaded on support rollers inclined at 5 deg. from the vertical and the speed of travel can be varied from 4ft to 12ft per minute to suit the condition of the plate surface. The cleaning plant can deal with both sides of plates up to 40ft long by 10ft wide at one pass: the cleaning chamber measures 12ft long by 4ft 9in wide by 12ft 6in high with baffled inlet and exit vestibules, 2ft long, at each end. There are six 19½in diameter by 2½in wide Wheelabrator wheels, each driven by a vee rope at 2250 r.p.m. and consisting of two steel plates held together by distance pieces into which are fitted eight blades of special alloy iron. Three wheels are mounted, in staggered positions, on each side of the chamber. Six sets of rubber-covered idler support rollers are installed within the chamber and vestibules and in the floor are power-driven grooved rollers to pass the plates through, and a variable speed gear provides a plate handling speed of from 4ft to 12ft per minute.

On each side of the cleaning chamber is a conveyor, about 40ft long, consisting of a vertical support framework, vertical rollers at 2ft 6in centres and grooved traversing rollers set at 5ft centres and chain driven by a 4 h.p. variable speed motor. Perforated steel plate ¼in thick forms the floor of the chamber, through which spent abrasive falls into sheet steel hoppers and then on to two belt conveyors for delivery to bucket elevators. From the top of these the reclaimed shot is discharged into an abrasive and dust separating chamber equipped with a power-driven rotary screen. The abrasive falls through the screen into an air wash by means of which light dust particles are drawn off and the abrasive drops into a storage hopper, fitted



Abrasive cleaning plant at J. L. Thompson and Sons, Ltd., showing control console



Abrasive plant for descaling sections at Smith's Dock Company, Ltd.

with gate valves, from which the cleaned shot is fed to the Wheelabrator wheels. A pipe delivers the abrasive to a small impeller wheel which is fastened to the main wheel and which feeds the abrasive through a hole in a control cage which is held stationary. The shot is fed tangentially on to the inner edge of the blades at low velocity and is discharged from the outer edge at high velocity, the speed of the main wheel being 2250 r.p.m. The position of the control cage is adjustable so as to give any required direction to the abrasive discharge. Extraction points in the chamber draw off the dust created by the shot blasting.

The machine is push button controlled and the abrasive employed is a round specially treated cut steel shot of a grade equivalent to B.S.S. 30 mesh. The dust collectors are of fabric filter pattern. To facilitate handling of the plate from stock, various mechanical devices have been developed and these manipulators are designed to deal with plates stacked horizontally either before or after cleaning. Interlocking devices ensure the maximum utilisation of the time cycle.

A machine for de-scaling sections has been developed and our illustration shows a unit installed at Smiths Dock Company, Ltd. The plant consists of a steel plate cleaning chamber measuring 7ft 3in by 5ft 6in by 7ft 9in high and provided with vestibules at each side. Within the length of the machine are three rubber-covered power-driven rollers which traverse the sections through the chamber. The cleaning rate averages 6ft per minute and as many sections as can be accommodated on the 3ft 6in wide conveyor can be treated. There are two 19½in diameter wheels, one above and one below work level, each driven by a vee rope at 2250 r.p.m., and they fire downwards and upwards and are angled to give maximum shot impingement. The abrasive recovery and cleaning system is similar to that described for the plate cleaning machine.

A protective coating is now available which can be applied at high speed and air dries rapidly, does not rely upon thickness for efficiency, is not detrimental to further fabrication processes, can be over-coated with any paint, and keeps steel rust free for the normal ship construction period. This is a non-aqueous transparent solution which has excellent bonding qualities and can be applied at low viscosity, depositing a film of micro-thickness which can be handled after a few minutes' air-drying. In its fully cured state the film resists normal abrasion and deep gouging of the metal surface will not chip the coating. The coating has been tested in association with a wide range of paint systems, while its rust inhibiting qualities prevent the spread of rust from any damaged area. Application of the material, which is lead free, can be by brushing, spraying, or dipping, and it has a covering capacity of 1000 square feet per gallon when sprayed and 1400 square feet when brushed.

HAND AND CLOTHING MONITORS.—We learn that the United Kingdom Atomic Energy Authority has ordered new hand and clothing monitors from E.M.I. Electronics, Ltd. These instruments are said to be the most advanced of their kind available. Dual phosphor scintillation counters have been used to measure both alpha and beta-gamma hand contamination levels simultaneously with separate meter readings. This avoids the use of air proportional counters, which are susceptible to changes in humidity when, say, the operator's hands have not been fully dried after washing. Another feature of the monitor is a scintillation counter which automatically corrects for variable background gamma radiation at levels up to 0·5mR per hour. The amount of correction applied to the hand counters can be varied individually to take into account directional background fields that cause an unequal proportion of radiation to reach the two hand chambers.

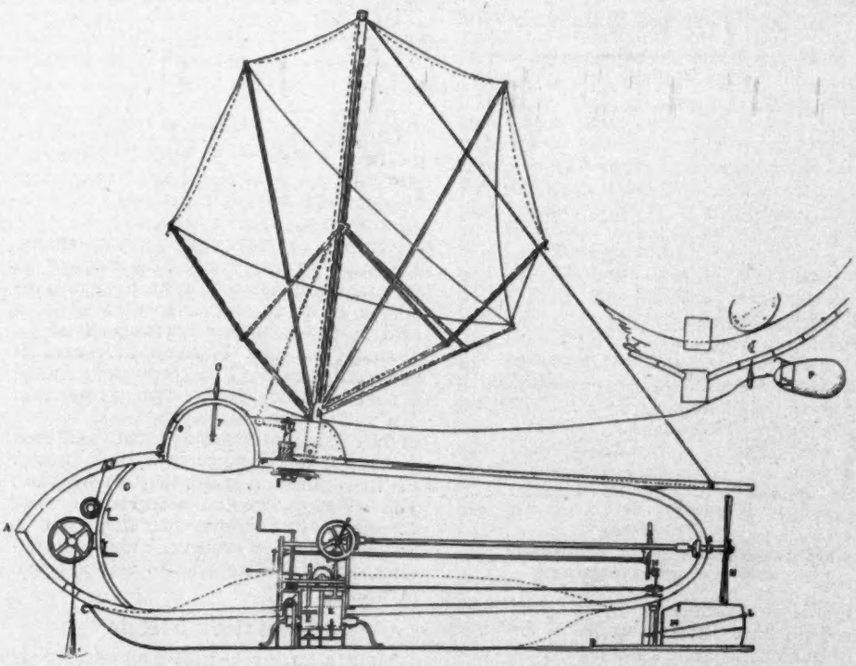
THE "NAUTILUS"

ROBERT FULTON, BORN IN PENNSYLVANIA IN 1765, WAS THE DESIGNER OF THE FIRST SUCCESSFUL SUBMARINE. HIS BOAT, THE "NAUTILUS", WAS CONSTRUCTED ON THE SEINE NEAR PARIS AND IN 1800 IT WAS LAUNCHED AND DEMONSTRATED BEFORE A COMMISSION APPOINTED BY NAPOLEON. LATER IT WAS TAKEN TO THE HARBOR AT BREST, WHERE, MANNED BY FULTON AND TWO FRIENDS, IT ATTACKED AND SANK AN ENEMY SHIP. IN TWO SUBSEQUENT ATTEMPTS IT FAILED DUE TO THE ENEMY BEING FOREWARNED.

THE "NAUTILUS" WAS A WOODEN VESSEL COVERED WITH SHEET COPPER. IT WAS 20 FEET LONG, 6 FEET IN DIAMETER, PROPELLED BY SAIL WHILE ON THE SURFACE AND BY A SERIES OF HAND LEVERS, GEARS AND A SCREW PROPELLER (ANOTHER OF FULTON'S INVENTIONS) WHILE UNDER WATER. THE RISE AND DESCENT OF THE BOAT WAS ACCOMPLISHED BY WATER BALLAST COMPARTMENTS AND FORCE PUMPS.

THE ATTACKING APPARATUS WAS A TORPEDO, CONSISTING OF AN EGG-SHAPED COPPER BARREL CONTAINING 100 POUNDS OF POWDER AND A GUN LOCK, THE TRIGGER OF WHICH WAS TO BE SET OFF BY CONTACT WITH THE OBJECT OF ATTACK. FOR THE PURPOSE OF PLACING AND FIRING THE TORPEDO THE FOLLOWING ARRANGEMENT WAS DEVISED. THROUGH THE CONNING-TOWER OF THE "NAUTILUS" PASSED A SHAFT, THE OUTER AND UPPER END OF WHICH TERMINATED IN A SCREW EYE. THROUGH THE EYE PASSED A TOW ROPE ATTACHED AT ONE END TO THE TORPEDO AND AT THE OTHER TO A SMALL WINCH INSIDE THE BOAT. THE CRAFT WAS TO BE STEERED UNDER THE KEEL OF ITS PREY AND THE SCREW EYE WAS TO BE IMBEDDED IN THE PLANKING BY A FEW BLOWS ON THE LOWER END OF THE SHAFT. THE "NAUTILUS" WAS THEN TO SET OFF, LEAVING THE SCREW EYE BEHIND, TILL THE TOW ROPE DREW THE TORPEDO INTO CONTACT WITH THE SHIP'S BOTTOM.

THE PLAN OF THE "NAUTILUS" TOGETHER WITH THE ARRANGEMENT FOR DISCHARGING THE TORPEDO IS REPRODUCED BELOW.



Above we reproduce a "print" sent to us by Mr. W. Owen, M.I.Mech.E. Now that a modern "Nautilus" has completed a voyage under the ice across the Arctic Ocean, it is interesting to see at the bottom of the print the design of an earlier and in its way as successful a "Nautilus." We are, however, puzzled about the origin of the print. The original measures 18⅜in by 10⅛in overall and the length from the top to the bottom of the drawing is 14in. It is printed on thin, translucent paper with a faint longitudinal striped herringbone pattern. Except that the shape is odd, it might be taken to be the flyleaf covering a colour plate in a book. If so, presumably the plate would have been a (full-length ?) portrait of Robert Fulton. Mr. Owen has had the print in his possession for a large number of years but has no knowledge of its origin

Metallurgical Topics

Chemistry and Metallurgy of Titanium

A MONOGRAPH*, published by the Royal Institute of Chemistry (30, Russell Square, London, W.C.1) describes the chemistry and metallurgy of titanium production, which has increased rapidly in recent years, the total titanium sponge production for U.S.A., U.K. and Japan being 3 tons in 1948 and some 28,500 tons in 1957. This development is due almost entirely to the requirements of the aircraft industry. Aluminium alloy components, employed up to about 200 deg. Cent., are cheaper than those in either titanium alloys or alloy steels. Above 400 deg. Cent. some alloy steels are superior; between 200 deg. and 400 deg. Cent. titanium has a better strength/weight ratio than either. Its resistance to brine, chlorites, chlorides, brackish waters, nitric acid, sulphur dioxide, organic acids and other chemicals—often better than that of the stainless steels and other corrosion-resistant alloys—should lead to its increasing use in the chemical and other industries, especially if the cost of fabricated parts can be reduced.

TABLE I.—*Physical Properties of Titanium Compared with Al, Cu, Fe and Mg*

	Ti	Al	Cu	Fe	Mg
Melting Point, deg. Cent.	1665±5	660	1084	1535	650
Density, g./c.c.	4·505	2·70	8·94	7·86	1·74
Therm. Cond., cal/cm/cm²/deg. Cent./sec (at 20 deg. Cent.)	0·0407	0·57	0·92	0·17	0·35
Resistivity, microhm-cm. at 20 deg. Cent.	55·4	2·68	1·72	10·0	4·4
Spec. Heat, cal/g/deg. Cent. (0—100 deg. Cent.)	0·126	0·211	0·093	0·109	0·245
Therm. Exp. Coeff., 10^{-6} deg. Cent. (0–100 deg. Cent.)	8·9	24·0	16·4	11·9	25·7
Mag. Susceptibility, 10^{-6} c.g.s. units/g	+1·25	+0·65	−0·086	Ferro-magnetic	+0·55
Normal Electrode Potential, volts	−1·75	−1·67	+0·52	−0·04	−2·38
Elastic Modulus, 10^6 pounds per square inch	15	10	17·5	29	6·5

The metal is obtained by the reduction of titanium tetrachloride by magnesium or sodium under an atmosphere of dry argon or helium, this reduction being effected batch-wise at temperatures above the melting point of the chloride of the reducing metal. After cooling, the titanium is separated in granular form from the halide, either by vacuum distillation at 1000 deg. Cent. or by aqueous leaching. The granular spongy titanium so produced is always melted under the arc in water-cooled copper crucibles. The resulting ingots, which may weigh up to 2 tons, are converted by machining, forging, rolling and extrusion into the usual variety of mill forms. Pure titanium has a body-centred cubic structure (β-phase). At 882·5±0·5 deg. Cent., it transforms to the α-phase, which has a close-packed hexagonal structure. The physical properties are compared in Table I with those of aluminium, copper, iron and magnesium.

Raw titanium from sodium or magnesium reduction has a hardness of 100–170 DPN, and is termed " commercially pure," although actually consisting of very dilute alloys of titanium with oxygen, nitrogen, hydrogen, carbon and iron. Properties vary with purity, typical properties being quoted in Table II.

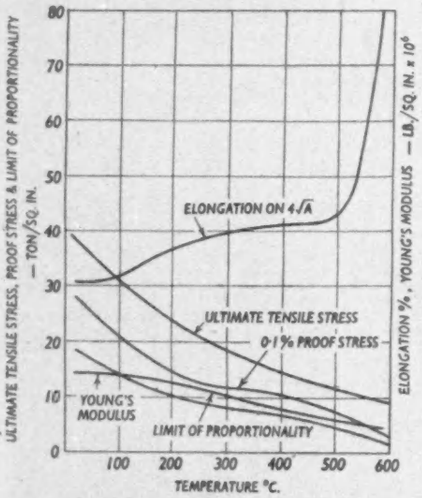

ULTIMATE TENSILE STRESS, PROOF STRESS & LIMIT OF PROPORTIONALITY — TON/SQ. IN.
ELONGATION %, YOUNG'S MODULUS — LB./SQ. IN. x 10⁶
ELONGATION ON 4√A
ULTIMATE TENSILE STRESS
0·1% PROOF STRESS
YOUNG'S MODULUS
LIMIT OF PROPORTIONALITY
TEMPERATURE °C.

Fig. 1—Tensile properties of commercially pure titanium at various temperatures

TABLE II—*Mechanical Properties of Annealed Commercially Pure Titanium*

Description (DPN)	Titanium 120	Titanium 130	Titanium 150	Titanium 160
Tensile Strength tons/sq in	30 (max)	25–40	35 (min)	40 (min)
0·1 per cent Proof Stress, tons/sq in	—	18 (min)	25 (min)	30 (min)
Elongation, per cent	20 (min)	15 (min)	15 (min)	12 (min)
Young's Mod., 10^6 lb/sq in	15–17	15–17	15–18	15–18
Fatigue Limit, per cent of Tensile Strength	50	50	50	50
Bend Radius (on sheet 16 s.w.g. or thinner)	2T	2T	3T	3T
Specific Gravity	4·52	4·52	4·52	4·52

The properties of titanium at various temperatures are shown in Fig. 1, but better properties can be obtained by alloying purer titanium with metallic constituents, to form substitutional solid solutions. Alloying constituents are α-stabilisers or β-stabilisers, according to whether they raise or lower the α–β transformation temperature. The addition of tin to titanium-aluminium alloys is used in two commercial α-titanium alloys, Titanium 371 and Titanium 317, used at moderately elevated temperatures ; when 371 shows particularly good creep resistance. The α-alloys are not easy to work, because of their hexagonal structure ; but, since their ductility is not impaired by cycling through the transformation range, they are weldable. The α/β-alloys are the strongest and most commonly used alloys, but they show a reduction in creep strength at high temperatures, and are susceptible to embrittlement in welding.

Refractory Metals

METALS for use at high temperatures are discussed by J. W. Pugh,* who devotes attention chiefly to tungsten, tantalum, columbium (niobium) and rhenium. In the past, most of the effort has been devoted to the search for a satisfactory molybdenum alloy with a coating, but some of the other refractory metals are stronger, some are more ductile ; and all, except rhenium, are more oxidation-resistant at high temperatures. All four metals can be arc-melted, sintered, forged, swaged and rolled. Probably, all may be extruded, if a technique as for molybdenum is employed. With some of them, there are certain requirements for successful fabrication. Thus, interstitial impurities, such as oxygen, are prejudicial to the working of arc-melted columbium, rhenium cannot be cold-worked more than some 30 per cent without intermediate annealing, and tungsten has a relatively high brittle-ductile transition temperature, and the fabrication temperature must thus be kept above the transition temperature characteristic of the structure being deformed. A summary of the properties of these metals is given in the table opposite with those of molybdenum for comparison. The metals are arranged from left to right in diminishing order of melting point, this order being almost the same as that of their densities. Refractory metals are comparatively stiff, but tantalum and columbium have Young's Moduli less than

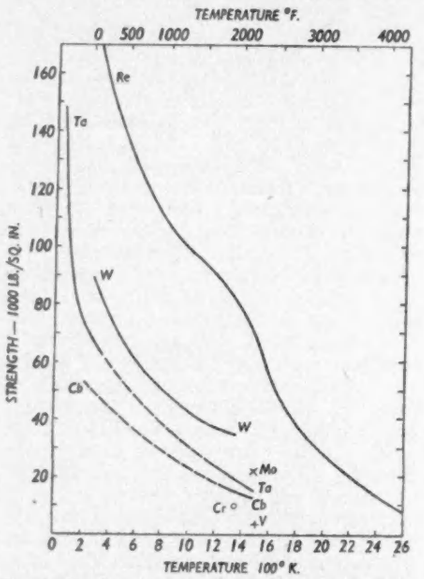


Fig. 1—Tensile strengths of refractory metals as a function of temperature

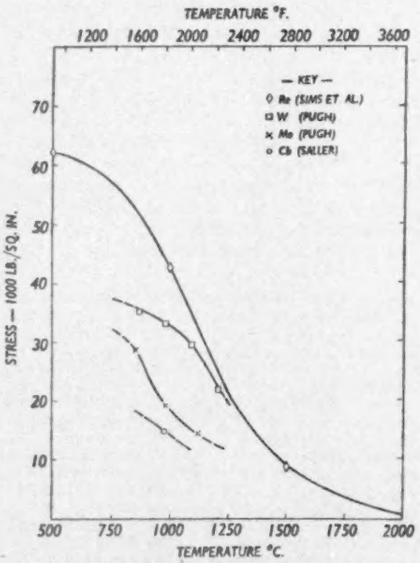


Fig. 2—Rupture strength as a function of temperature for 10-hour life

* By J. J. Gray and A. Carter, No. 1 in the 1958 series, *Lectures, Monographs and Reports.*

* *Journal of Metals*, May 1958, page 335.

that of steel. Rhenium is the only refractory metal with a hexagonal close-packed structure, this probably accounting for its great susceptibility to work-hardening. It should be noted that rhenium is not hot-workable except in a protective atmosphere, because it forms a heptoxide, Re_2O_7, which liquefies at 279 deg. Cent., occurring at the grain boundaries. Thermal expansion coefficient and conductivity are indicative to some extent of thermal shock resistance, tungsten having the most favourable combination of these properties. Tungsten and tantalum have the lowest vapour pressures, being thus most commonly used in the lamp and electronic tube industries.

Properties of Refractory Metals

Property	W	Re	Ta	Mo	Cb
Melting Point, deg. Cent.	3410	3180	2996	2625	2415
Density, g./c.c.	19·3	21·0	16·6	10·2	8·57
Young's Modulus, 10^6 lb per square inch	51	67	27	47	15·1
Structure	BCC	HCP	BCC	BCC	BCC
Recrystallisation Temperature, deg. Cent. (1 hour)	1565	1400	1275	1130	1050
Lineal Thermal Expansion Coefficient (10^{-6} per deg. Cent.)	4·45	6·7	5·9	5·6	7·1
Thermal Conductivity, cal./cu. cm./deg. Cent./sec.	0·48	0·17	0·13	0·35	0·125
Vapour Pressure, μ at 2225 deg. Cent.	$1·38\times10^{-4}$	$1·18\times10^{-3}$	$7·94\times10^{-4}$	0·50	$1·66\times10^{-3}$
Cost for powder, dollars per pound	4·75	680·0	43·0	3·40	100·0

The tensile strengths of the four metals being considered are plotted in Fig. 1 as a function of testing temperature, rhenium being obviously superior over the whole temperature range ; this being due largely to its great strain-hardening capacity. The columbium curve shows a dotted portion, because reliable data at intermediate temperatures are lacking. Single-point data for some other metals are plotted for comparison. Except that tantalum is slightly out of line, the strength level appears to be in the order of the respective melting points. Fig. 2 shows creep rupture strength as a function of temperature for a ten-hour life. Molybdenum is compared with tungsten, rhenium and columbium, no data for tantalum being available. Rhenium shows less superiority over tungsten at the high temperatures. Molybdenum and columbium appear considerably weaker. Rhenium is most outstanding at lower temperatures and for shorter times. The order of superiority for body-centred cubic metals again appears to be related to their melting points.

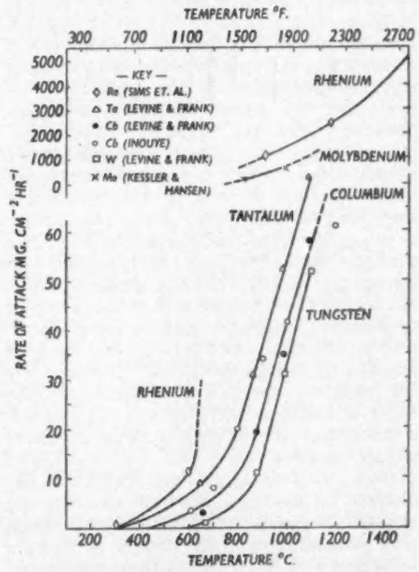


Fig. 3—Relative oxidation attack for one hour exposures as a function of temperature

Fig. 3 shows the relative oxidation attack of the metals for one-hour exposures as a function of temperature. Rhenium has the worst and tungsten the best performance, but none is suitable for high-temperature application. No satisfactory solution of this problem has yet been found ; that most possible being the development of oxidation-resistant alloys, in conjunction with satisfactory protective coatings. In this connection, two developments are promising. One is the extension of the molybdenum disilicide coating technique to tungsten. The tungsten disilicide coating can readily be produced by the catalytic reduction of silicon tetrachloride, and is said to give prolonged protection up to 1500 deg. Cent., a temperature some 100 deg. Cent. higher than the effective range of molybdenum disilicide. Such coatings, however, are even more brittle than the molybdenum disilicide coatings at room temperature. The other is the fact that alloys of titanium and columbium containing ternary additions of molybdenum, chromium and vanadium, show an oxidation-resistance some ten times that of unalloyed columbium. So far, little effort has been expended on the development of tungsten, tantalum, rhenium and columbium alloys. Among positive results, however, are the discovery that the addition of rhenium to tungsten causes room-temperature ductility, and the addition of titanium to columbium promotes fabricability. From the viewpoint of high-temperature application, there is thus a large and profitable region to explore ; and the paper contains thirty-five references to original work which can be consulted.

Nitriding Combined with Induction Hardening of Low-Alloy Steel

WHEN most low-alloy high-tensile steels are nitrided, the maximum surface hardness, even under optimum conditions, is about Rockwell C 58. If lapping or grinding is necessary, the final surface hardness will be much lower. It has been shown by P. M. Unterweiser,* however, that by combining conventional nitriding with a high-frequency induction-heating cycle, the case hardness can be so increased as to approach that obtainable only with Nitralloy steels, and the reduction of hardness with depth is very much reduced. This has been shown by comparative tests on A.I.S.I.—4340 steel, of composition as follows : C, 0·38–0·43 per cent ; Si, 0·20–0·35 per cent ; S, 0·040 per cent (max.) ; P, 0·040 per cent (max.) ; Mn, 0·60–0·80 per cent ; Ni, 1·65–2·0 per cent ; Cr, 0·70–0·90 per cent ; Mo, 0·20–0·30 per cent. Samples from 1in diameter bar stock of this steel were hardened under a protective atmosphere and tempered to produce four "core" hardness levels : R. C 20–21, 24–25, 30–31, and 35–36. The temperature required to obtain R. C 35–36 was safely above the nitriding temperature, ensuring that the samples would not alter in core hardness during the nitriding cycle. This was conducted at 975 deg. Fah. (524 deg. Cent.) for twenty-five hours in a single-stage cycle, the rate of ammonia dissociation being maintained between 20–30 per cent throughout the cycle. The hardness results for the nitrided cases at the four core hardness levels are shown, as a function of case depth, in Fig. 1. It will be seen that surface hardness is a function of core hardness.

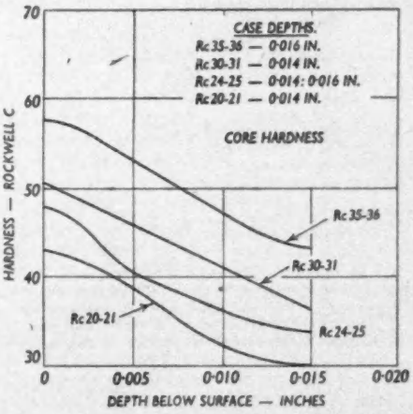


Fig. 1—Nitrided case hardness in relation to depth

* *Iron Age*, June 19, 1958, page 122.

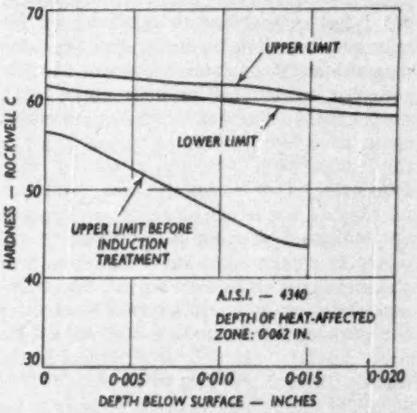


Fig. 2—Nitrided case hardness in relation to depth after induction heating treatment

After nitriding, all samples were subjected to the same induction heating cycle—heating to 1600 deg.–1650 deg. Fah. (871 deg.–899 deg. Cent.) in 2½ seconds and quenching in oil ; the time at maximum temperature being thus only a small fraction of a second. As a stress-relieving measure, all samples were held at 400 deg. Fah. (205 deg. Cent.) for one hour, and air cooled. The hardness values after this combined treatment are shown, as a function of case depth, in Fig. 2. The highest surface hardness was obtained on the samples with a core hardness of R. C 35–36. Even at the lowest core hardness level (R. C 20–21), a minimum surface hardness of R. C 62 was obtained, this representing an increase over the surface nitrided only of nearly 20 points Rockwell. The depth of zone affected by induction heating was 0·062in. At the upper limit of case hardness, a hardness of R. C 60 was held to a depth of nearly 0·020in. A minimum of R. C 60 was held to a depth of 0·012in at the lower limit. It is suggested that, when such steel is nitrided in the conventional manner, a maximum hardness of R. C 58 cannot be exceeded because too great a quantity of the carbide-forming elements has been precipitated before nitriding. Induction heating tends to put the carbides back into solution, thus making them available for further combination. In the presence of nitrogen contained in the case, additional nitrides are formed, accounting for the increase in hardness. It is thought that steels of the En 24, 25, 26 and 110 series should be similarly responsive to this combined treatment.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SPEED RESTRICTIONS

SIR,—I have read Mr. Livesay's article on pages 246 to 250 with the usual enjoyment, but I feel constrained to comment on his reference to a point in British practice. He suggests that if a locomotive driver has forgotten a written (or printed) notice of a special speed restriction at some point on his route, he is likely to run at normal speed at this point, with possibly dangerous consequences. That is not the case. All such restrictions are clearly marked on site and an additional warning is presented to the driver at a point that leaves him plenty of distance in which to slow down. The warnings are given by lamps specially erected for the purpose, or by appropriate use of the fixed signals. (If the driver ignores the signals, there is nothing to be done.) The object of the printed notice is to inform the driver of a temporary speed restriction that will mean delay and to suggest that he should endeavour to get some time in hand to offset it. It is not part of the signalling system.

The attention commonly directed to printed notices when investigating accidents due to overspeed at formally restricted points is most misleading in its irrelevance. The right place to warn a driver of a temporary speed restriction is on the immediate approach to it and that is standard British practice. No printed notice could possibly be made into an essential safety measure if only because the necessity for imposing a speed restriction or a change of route may arise after some of the trains concerned have already made their last scheduled stops before reaching the point concerned. The cause of the Milton derailment was not the forgetting of printed instructions, but the failure to note that the relevant fixed signals were clearly indicating a low-speed diversion. The driver of the train derailed at Sutton Coldfield was thoroughly familiar with the route and no reason was discovered for his failure to comply with the permanent speed restriction there. Whether he would have been helped by a printed reminder of something he had known for years seems doubtful.

W. A. TUPLIN

Sheffield,
August 20, 1958.

TRANSATLANTIC TELEGRAPHY

SIR,—I have read your very interesting article on the centenary of transatlantic telegraphy in your issue of August 15, and I feel sure that many of your readers will have wondered who made these early Atlantic telegraph cables. Although the project of 1858 was the product of the imagination and enthusiasm of the retired American business man, Cyrus Field, it is not generally known that the enterprise was largely financed and the cable wholly manufactured in England. In fact, all of the core for the cable was made by the Gutta Percha Company of City Road, North London, where the first submarine telegraph cable between England and France was produced in 1850, and the armouring was shared by Glass, Elliot and Company of East Greenwich and Newall and Company of Birkenhead. The laying was shared by the British and Americans.

Although the cable was short-lived the knowledge and experience gained in the manufacture, laying and operation of the cable led to the second and successful attempt eight years later. To carry out the project, the Gutta Percha Company and Glass, Elliott and Company were amalgamated in 1864 to form The Telegraph Construction and Maintenance Company, Ltd., which not only produced two Atlantic cables but chartered the famous "Great Eastern" to lay them in 1865 and 1866. Almost a hundred years later, Submarine Cables, Ltd., which had been formed in 1935 to amalgamate the submarine cable interests of Siemens Brothers and Company, Ltd. (now Siemens Edison Swan, Ltd.) and The Telegraph Construction and Maintenance Company, Ltd., produced at Erith in Kent over 90 per cent of the first Atlantic telephone cable which was inaugurated in 1956.

To-day, Submarine Cables, Ltd., is producing a large part of the second Atlantic telephone cable to be laid between France and America in 1961.

P. L. REED,
Public Relations Officer

Telegraph Construction and
Maintenance Company, Ltd.,
August 18, 1958.

RAILWAYS INTO ROADWAYS

SIR,—The following extract from a paper read before the Electric Railway Society recently, entitled "London Bridge Rush Hour," may interest your correspondents :

London Bridge—Down Trains
5.00-5.59 p.m., Monday to Friday

Eastern Section (platforms 1–3) :		
Passing—Steam	5	
Diesel-electric	3	
Calling—Electric...	42	(*a*)
Total ...	50	
Central Section (platforms 8–10, 12–22) :		
Starting via Main Line :		
Steam	3	
Electric—Brighton, &c.	10	
Suburban	16	(*b*)
Via South London Line :		
Electric—Suburban	15	(*c*)
Total ...	44	

(*a*) includes 39 ten-coach trains with 958 2nd class seats.
(*b*) includes 3 ten-coach trains with 958 2nd class seats ; includes 13 eight-coach trains with 772 2nd class seats.
(*c*) includes 12 eight-coach trains with 772 2nd class seats.

G. T. MOODY

Tulse Hill,
August 19, 1958.

Book Reviews

Engineering Economics : Elements of Industrial Organization. By T. H. BURNHAM, B.Sc., B.Com., A.M.I.Mech.E., and G. O. HOSKINS, O.B.E., B.Com., M.Sc. Sir Isaac Pitman and Sons, Ltd., 39, Parker Street, London. W.C.2. Price 21s.

THIS book was written with a dual purpose—first, to give a knowledge of the economic system of production and distribution to the engineer who wishes to understand the general principles of the economic system of the organisation of which he forms a part, and, secondly, as a textbook for students working for Section A (Fundamentals of Industrial Administration) of the examination of the Institution of Mechanical Engineers, and that of other professional bodies. The *Journal of the Institution of Mechanical Engineers* described it as "the only book which covers the broad syllabus" of its examination, while the fact that this is the sixth edition would appear to indicate its usefulness. Written originally by Mr. Burnham, latterly Mr. Hoskins was associated with him. As the fifth edition appeared as long ago as 1940 it was obvious that with the many changes that have taken place a revision was necessary. However, the death of Mr. Burnham in 1952 postponed matters until Mr. Hoskins was able thoroughly to revise the whole book and to write a new chapter dealing with the way the State has invaded industry.

A wide field is covered in this book, which begins with an explanation of the elements of economics, and then passes on to money, banking and exchange, followed by an investigation of Commonwealth and world resources ; it is somewhat disappointing to read that as regards the productivity of the miner the United Kingdom is behind both the U.S.A. and Germany. In considering industrial evolution an interesting chart of the population of the British Isles from A.D. 1100 shows how rapid was the increase since the industrial revolution and the advent of steam, electricity and atomic power. After dealing with business organisation, an interesting chapter on the trade cycle is devoted to the consideration of the incidence of slumps and booms, and how the former can be handled, mentioning the methods adopted in various countries. The necessity for adequate control is stressed, and the value of statistics and charts is emphasised, a description of the various forms of charts in use being given. The subject of forecasting and budgeting is also included in the chapter on control. Separate chapters are devoted to industrial legislation, and industrial relationships, in the former of which a description is given of the development of trade unions, to be followed by employers' associations, while the value of arbitration is pointed out. Research and development work are given a chapter, and the question is raised as to whether research in a factory pays ; while it can be highly remunerative, much money may be wasted if the object of the research is not clearly defined. The book proceeds to investigate organisation of distribution, and passes on to office administration, on which we find the view expressed that "time and motion studies are useful in the office as in production, and the same rules apply ; for example, adequate allowances must be made for fatigue and rest pauses."

We cannot help wondering how many offices are conducted on these lines. Passing now to the management function, the authors are of opinion that "attention has in the past been devoted too exclusively to the external forms of organisation, and insufficiently to the human element on which real efficiency must finally depend." We agree, but other matters are also important and the authors recognise this, for although they give power of leadership as the first quality to be demanded in a manager, other necessary qualities are stated and these are so very comprehensive that we have not met the manager who possesses them all. We are interested in the specification given for personnel rating for promotion to managerial rank. We are somewhat surprised that no reference is made to the way in which technical colleges can help in the important matter of suitable training for efficient management. Two chapters are devoted to the important subjects of taxation and insurance, both of which are helpfully discussed. In the concluding chapter on the State in industry, Mr. Hoskins gives his personal views after setting out the general position, and how the State came into industry not only as the result of a war which necessitated centralised control of production, but also in periods of acute depression. In pre-war days, both Fascist Italy and Germany played important parts in industry, while the U.S.S.R. assumed actual control. In Britain the Socialist Government introduced nationalisation to a considerable extent, including the Bank of England, the coal mines, the steel industry, electricity and gas production, railways and inland waterways, road haulage and overseas communications. Mr. Hoskins is of opinion that while some of these should remain under the State it would be unfortunate if others were made a political target and successively denationalised and then nationalised, and so on.

The foregoing gives a brief outline of the vast field that is covered by a useful and readable work. The authors, fully realising that they could not deal comprehensively with it, have accordingly given at the end of each chapter the titles of books suitable for a student who wishes to go further into the subject, these books being arranged in two categories : those which are (*a*) easy to read, and (*b*) more advanced works. This subdivision is very useful and might well be copied in other bibliographies.

Mr. Hoskins has certainly done well in his thorough revision of the whole work, and in bringing all the statistics up to date. Engineering students who aspire to become executives will do well to study it, as well also as managers and supervisory staff who wish to understand the somewhat complex problems which have a profound effect on their profession.

Irrigation and Hydraulic Design. Vol. 2 : Irrigation Works. By SERGE LELIAVSKY. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 294s. net.

THIS is the second volume of Dr. Leliavsky's trilogy. The first volume appeared early in 1955, when we took the opportunity* of stressing the importance of the author's undertaking, the excellence of his qualifications and the breadth of his approach. In the intervening span of three years, he has acquired an even wider following of appreciative readers in this country and lost none of his versatility, his attractive presentation, or of his intellectual enterprise. The first volume was entitled *General Principles of Hydraulic Design*. In this second volume, the hydraulic analysis and theory are, therefore, dealt with more briefly and more attention is paid to structural problems.

Chapter 4 of the work, the first in this volume, is devoted to the design of regulators. It begins with two sections on the hydraulics —theoretical and practical—which will be of special interest to those readers to whom the first volume appealed. Dr. Leliavsky has proved himself to be capable of absorbing new concepts as they are published by other pioneers, and indeed eager to apply new developments in basic mechanics both of fluids and of solids, and it is, therefore, a challenge to hydraulic researchers with definite views on modern developments to see the author's use of such old formulæ as that of DuBuat.

Following the sections on hydraulics, there are six sections on the structural design of regulators, with a discussion of the loads, and with many design details taken from the author's own experience and from publications which appeared in various parts of the world. Masonry, plain and reinforced concrete design and the arrangement of regulator (or barrage) gates are all discussed in a manner which may be of interest to designers concerned with hydraulic structures in fields other than irrigation.

Chapter 5, on "The Design of Irrigation and Drainage Syphons," begins by explaining that the spelling of "syphons" indicates a common flaw in the habits of the Egyptian and Indian Irrigation services : "syphon" being the short name for an inverted siphon as employed in connecting two canals under a third. Again, a section on the hydraulics of such culverts or pipes is followed by several sections on the structural problems in steel, masonry (or mass-concrete), and reinforced concrete work. Examples of the application of the author's ideas are given in sufficient number to assist designers both at the senior and the junior levels.

Weirs and chutes, flumed constrictions, spillway siphons, and sediment traps and excluders are dealt with in Chapter 6. There is a certain unevenness in standards—the old-fashioned diagram of weir discharge is followed by a more up-to-date discussion of form drag and boundary shear—but the examples of various structures quoted and illustrated are well-discussed in a manner based on first principles.

Chapter 7, on the planning and design of a perennial irrigation scheme, is concerned with problems which mainly affect the irrigation engineer ; the location and design of canals and drains and of canal outlet works. Much information has been collected from agricultural engineering sources, largely in Egypt and in the United States, to provide the data on which the irrigation engineer is to base his work.

The longest chapter of all is the last one, in Volume 2, on canal bridges—both fixed and movable—and aqueducts and gates. At the very start the author counters the objection which inevitably comes to mind (that bridge design is hardly a part of irrigation engineering) by stating that 30 to 50 per cent of the working time of the design office in an irrigation service is devoted to bridges. Whatever views he may hold on that, the reader will find this chapter a model of the author's work : it ranges over a wide variety of materials, design techniques and basic ideas, putting the working diagram or table or chart next to a discussion of recent papers which serve to stimulate the reader's interest in the scientific basis of the day-to-day work. After a briefer section on pipe aqueducts, vertical-lifting steel gates are treated here because of their fundamental similarity to steel bridges. Any engineer designing flow-control works on a large scale will be interested in this section (part of which summarises two articles written by Dr. Leliavsky some years ago for this journal), and it might be noted by the way, that one of the illustrations—Fig. 698—contains a modest photograph of the author.

Progress in engineering may come about in a variety of ways : as a result of new basic scientific discoveries, or in consequence of novel applications of an existing body of scientific knowledge, by a synthesis of the activities of specialists in hitherto unconnected fields, or by efforts of organisation in the field broadly called management. If management includes the art of inspiring men to do better work than before, it seems fair to claim that Dr. Leliavsky has made his contribution in all these ways.

Automobile Electrical Equipment. Sixth edition. By A. P. YOUNG and L. GRIFFITHS. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 30s.

THE Foreword suggests that this sixth edition of a work first published in 1933 draws "attention to more recent developments relating to p-n junction type rectifiers, electrical control in car transmission systems, and also impulse magnetizers." In fact, the whole of the omissions from the fifth edition, observed in these columns on February 10, 1956, persist ; no automatic transmission control, not even the automatic system that has now supplemented the manual selection described for the Laycock - de Normanville overdrive, is described, and even the wholly electric Smiths transmissions escape reference. It now becomes necessary to point out the absence from the text of capacitance and motor-driven flashing light controllers, of engine heaters utilising the transformer iron losses, of sealed beam lamps with reference points for mechanical setting, of optical head-lamp setting devices, of resistance heating of glass, of transistorised receivers, and of fuel-burning heaters. We are still unable to reconcile ourselves to the neglect of double-lever contact breakers with one-lobe-per-cylinder cams, particularly since a picture of the Ford V-8 distributor still appears and there is some discussion of the influence on performance of the contact-breaker dwell period. Purchasers of the volume may wish to be advised that the promised treatment of impulse magnetisers is to be found on pages 348 *et seq.*

Books Received

Electrical Furnaces. Edited by C. A. Otto. George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 35s.

Electrical Maintenance and Repair. By J. L. Watts. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 21s.

Nuclear Reactor Experiments. Edited by J. B. Hoag. D. Van Nostrand Company, Ltd., 358, Kensington High Street. London, W.14. Price 51s.

Kernverfahrenstechnik eine Einführung für Ingenieure. By W. Mialki. Springer-Verlag, Reichpietschufer 20, Berlin W 35, Germany. Price DM.78.60.

Metallurgical Abstracts. General and Non-Ferrous. Vol. 24, 1956–57. Editor, J. S. Bristow. The Institute of Metals, 17, Belgrave Square, London, S.W.1.

Influence Lines for Continuous Beams. By W. C. Boyer and J. I. Abrams. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 80s.

Handbuch der Werkstoffprüfung. 2nd Edition. By E. Siebel and N. Ludwig. Springer-Verlag, Reichpietschufer 20, Berlin W 35, Germany. Price DM.148.50.

Analytic Geometry of the Three Dimensions. By George Salmon. Chelsea Publishing Company, 552 West 181 Street, New York 33, N.Y., U.S.A. Price 4·95 dollars.

* THE ENGINEER, May 27, 1955, pages 743–744.

Discharge Coefficient of an Elementary Steam Nozzle

By DENIS J. RYLEY AND HENRY BARROW*

The discharge coefficient of an elementary convergent-parallel nozzle passing superheated steam at low pressure was determined by the authors by comparing the condensed efflux with the theoretical flow. An attempt was made to correlate the values thus obtained with values predicted by considering the growth of a turbulent boundary layer. The agreement was good for a small fall in pressure, a condition approximating to incompressible flow, but less satisfactory for a sub-critical back-pressure. Some suggestions are advanced to account for the disparity.

THE nozzle lies at the heart of the steam turbine and it was inevitable, therefore, that much experimental and theoretical work should have been done on nozzles during the early decades of the present century. This work is much too extensive to be quoted in detail here, but may be broadly summarised as follows.

Early researches concentrated principally on relating discharge to flow area and terminal conditions (Rateau,[1] Gutermuth,[2] *et al.*). In order to explore the state of the steam during the actual expansion, various methods were employed to measure the local value of some function of state. Thus, Batho[3] and Müller[4] measured the variation of static temperature. Stodola,[5] Mellanby and Kerr,[6] *et al.*, made measurements of static pressure, while Löliger[7] attempted both static and dynamic measurements concurrently. The need to establish reliable values for efflux velocities for nozzle profiles in common use led to a number of researches directed towards obtaining velocity coefficients, some workers (Steam Nozzles Research Committee of the Institution of Mechanical Engineers,[8] Giffen and Crang,[9] *et al.*) employed the impulse plate, while others (Christlein,[10] *et al.*) favoured the reaction balance. As the contemporary outlook in aerodynamics began to influence workers in steam flow, the importance of the Reynolds' number began to be recognised (Guy,[11] Dollin,[12] *et al.*). In the meantime, the advantages of air as a working fluid had not been overlooked and Wadlow,[13] Stewart,[14] Jude,[15] Morley,[16] *et al.* had conducted researches with nozzles discharging air.

Experiments directed to exploring superheat in flowing steam form a distinct group presenting their own special problems, and this subject lies outside the scope of the present paper.

Investigations into the growth and behaviour of boundary layers by aerodynamicists have resulted in the accumulation of much knowledge which might profitably be employed to advance the study of losses in steam nozzles,[17] and the time would seem ripe to attempt to apply some techniques, well-established for the case of air, to the case of flowing steam.

Scope of Present Experiments

With this end in view, the authors decided to investigate, in the first instance, the case of an elementary nozzle form; the convergent-parallel or "quadrant" nozzle. The nozzle profile is shown in Fig. 2. This type of nozzle was chosen partly because of the high accuracy with which it can be manufactured and measured and also because an analytical treatment for this profile had been published by Simmons.[18] Simmons stated the discharge coefficient as a function of the nozzle geometry and the Reynolds' number based on exit conditions.

Since it was proposed to employ the perfect gas equations for certain of the calculations of theoretical discharge, it was necessary to employ as low a pressure as practicable, together with the highest possible value of superheat. Both of these desiderata were circumscribed by the limitations imposed by the plant. The lowest value of inlet pressure was about 30 lb per square inch absolute, a consequence of the use of an atmospheric condenser. The maximum inlet temperature was about 400 deg. Fah., the highest value obtainable from the independently-fired superheater under very light conditions of loading.

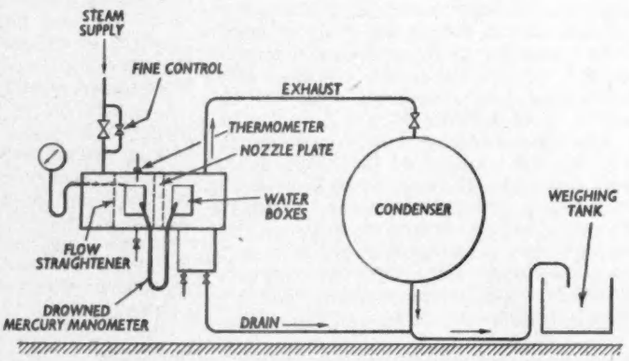


Fig. 1—Diagrammatic arrangement of nozzle testing plant

It was also imperative to ensure that the end point of the expansion was within the superheated region to obviate any possibility of supersaturation.

The general arrangement of the plant is shown diagrammatically in Fig. 1. It will be observed that no pumps were employed on the condenser and the condensate drained via a weir into a weighing tank. In this way gland leakage losses and irregular delivery were avoided and very close agreement obtained between original and confirmatory tests.

It is not possible to obtain readily for a given nozzle a large exit Reynolds number variation. The viscosity, μ_2 is insensitive to temperature and only a small variation in density, ρ_2, is possible. Moreover, the exit velocity, U_2, can only be varied from sonic down to a value determined by the necessity of making accurate measurements of pressure difference across the nozzle. It was considered that 2in of mercury was the minimum differential pressure needed to render insignificant the errors involved in reading the vertical manometer. This corresponds to an exit velocity of 330ft per second at the minimum. The possible variation of Reynolds number was about $2{\cdot}18\times10^5$, i.e. from $3{\cdot}72-1{\cdot}54\times10^5$. Tests were, therefore, conducted: (*a*) with a pressure difference across the nozzle of about 2in mercury, and (*b*) with a subcritical back pressure, representing, respectively, both incompressible and compressible flow.

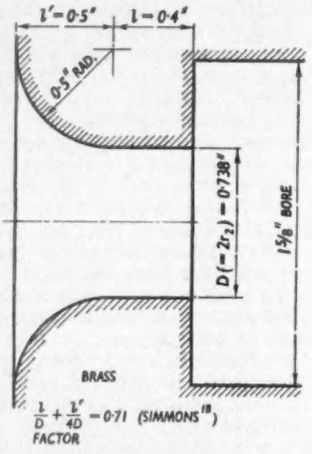


Fig. 2—Nozzle profile

Theory

The presence of friction within the body of and at the boundary of a flowing fluid reveals itself as a reduction in the mass discharge below the value which would be obtained in its absence. It is usual to regard the latter as a theoretical or ideal discharge and to define a discharge coefficient as the ratio of the observed to the theoretical value. It is now known that the boundary is more significant in reducing the discharge below the ideal than are irreversible actions within the main body of the flow. Accordingly, the view is taken here that the boundary layer is solely responsible for the losses and that it operates in this connection by reducing the effective exit area of the nozzle. If it is assumed, therefore, that the mainstream

* Department of Mechanical Engineering, University of Liverpool.

Notation.—

U—Velocity.
τ—Shear stress.
x—Axial distance from commencement of boundary layer development.
y—Distance from wall.
r—Nozzle radius.
μ—Absolute viscosity.
ρ—Density.
I—Enthalpy.
T—Temperature.
p—Pressure.
v—Specific volume.
m—Mass flow.
γ—Isentropic index.
g—Gravitational constant.
C_D—Discharge coefficient.
δ—Boundary layer thickness.
M—Mach Number.

$\delta^* = \frac{1}{U_0\rho_0}\int_0^\delta (U_0\rho_0 - U\rho)dy$.—Boundary layer displacement thickness.

$\vartheta = \frac{1}{U_0^2\rho_0}\int_0^\delta \rho U(U_0 - U)dy$.—Boundary layer momentum thickness.

$H = \delta^*/\vartheta$—Shape factor.
$D = 2r_2$—Exit diameter.
$Re_D = U_2D\mu_0/\rho_0$—Reynolds' number.
$Re_\vartheta = U_0\vartheta\mu_0/\rho_0$—Reynolds' number.
$(l/D + l'/4D)$—Nozzle geometry factor (see Fig. 2).
A—Flow area.

Suffices.—

w—Wall.
0—Mainstream.
1—Nozzle inlet.
2—Nozzle exit.

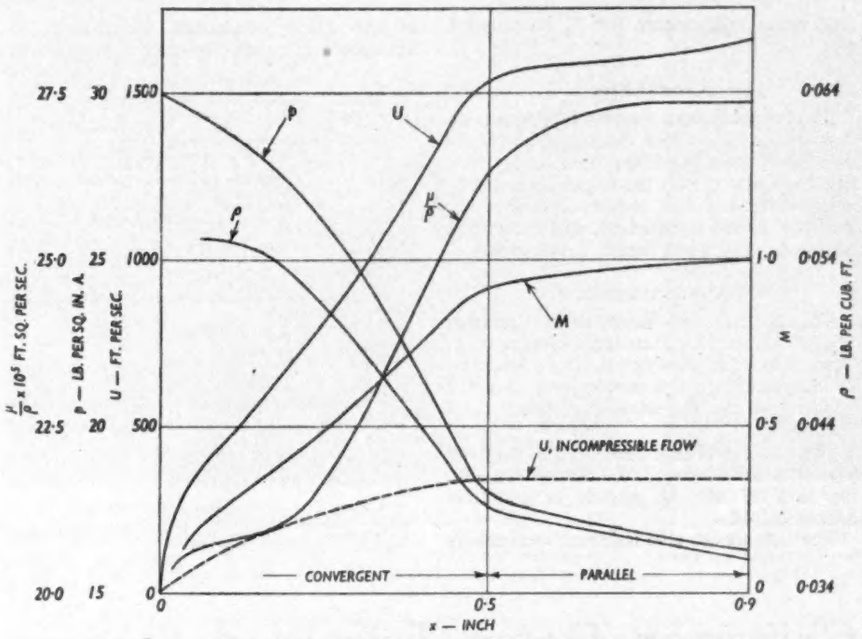


Fig. 3—Axial distribution of flow variables

expansion is isentropic, the discharge coefficient may be regarded as the ratio of effective to actual exit area. Hence,

$$C_D=\frac{(2r_2-2\delta_2^*)^2}{(2r_2)^2}$$
$$\doteqdot 1-\frac{2\delta_2^*}{r_2}=1-\frac{2H_2\theta_2}{r_2} \quad . \quad . \quad . \quad (1)$$

To obtain the quantities θ_2 and δ_2^* it is necessary to solve the momentum integral equation, which for axi-symmetrical compressible flow is

$$\frac{d\theta}{dx}=\frac{\tau_w}{\rho U_0^2}-\frac{\theta}{2}\left[\frac{H+2}{U_0}\cdot\frac{dU_0}{dx}+\frac{1}{\rho_0}\cdot\frac{d\rho_0}{dx}+\frac{1}{r}\cdot\frac{dr}{dx}\right]$$
$$. \quad . \quad . \quad . \quad . \quad (2)$$

To solve this equation a step-by-step method has been employed, for which purpose the axial distribution of the quantities U_0 and ρ_0 may reasonably be calculated from the standard one-dimensional theory.

Concerning the kind of boundary layer flow, evidently there will be initially a laminar layer, followed by transition conditions terminating in a turbulent layer, and a rigorous treatment would necessitate a tripartite calculation. In the present work, however, it has been assumed that a fully developed turbulent layer arises from the inlet section.

The shearing stress was determined from the Squire-Young[19] relation

$$\frac{\tau_w}{\rho U_0^2}=(3\cdot59+2\cdot56\log_e Re_\theta)^{-2} \quad . \quad . \quad (3)$$

which applies to a fully developed turbulent boundary layer on a flat plate. For the evaluation of Re_θ, the viscosity of steam was calculated from Sigwart's[20] expression

$$\mu=(0\cdot143T+56)\times10^{-7} \text{ lb per ft sec} \quad . \quad (4)$$

The axial displacement of stations for calculation was normally 0·2in, but was reduced to 0·1in for the convergence.

The value to be assumed for the shape factor, H, was not readily evident. In earlier calculations a constant value of 1·2 was employed for all stations. Subsequently for the compressible case only a variable value of H ranging from 1·32 to 1·75 was employed, the value being taken from data tabulated by Tucker[21] for an assumed velocity profile defined by a one-seventh power law.

For δ^* and θ the expressions defined in the notation were employed as the case may be considered to be one in which the ratio of the boundary layer thickness to the local radii of curvature of the boundary is very small. The axial distribution of the various derived quantities is as shown in Figs. 3 and 4.

One of the objects of the present inquiry was to align the values of discharge coefficient as calculated by boundary layer theory for diminished effective flow area with values of the coefficient as determined by traditional methods. In the latter case it has been usual to compare an actual

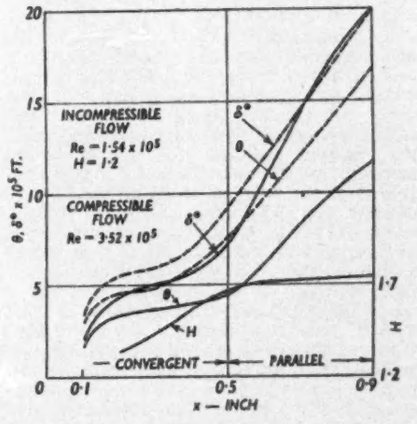


Fig. 4—Axial distribution of θ and δ* (steam flow)

measured discharge with an ideal theoretical value calculated as follows.

Two ways of assessing ideal discharge have customarily been employed. One assumes that the fluid is a perfect gas and expands subject to the isentropic law $pv^\gamma=$ constant. For one-dimensional irrotational flow this leads to the well-known equation of St. Venant and Wantzel.

$$m=A_2\sqrt{\frac{2g\gamma}{\gamma-1}\left(\frac{p_1}{v_1}\right)\left[\left(\frac{p_2}{p_1}\right)^{2/\gamma}-\left(\frac{p_2}{p_1}\right)^{\frac{\gamma+1}{\gamma}}\right]} \quad (5)$$

The other method makes use of the mass continuity equation for the controlling section, i.e.

$$m=\frac{A_2U_2}{v_2} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where v_2 is obtained from the tabulated properties of the gas or vapour and U_2 is obtained from

$$U_2=223\cdot8\sqrt{I_1-I_2} \quad . \quad . \quad . \quad (7)$$

The values of I_1 and I_2 are those appropriate to the known terminal conditions.

In cases where the pressure drop is very small and the fluid can be considered incompressible, equation (5) reduces to

$$m=A_2\sqrt{\frac{2g(p_1-p_2)}{v}} \quad . \quad . \quad (8)$$

For comparison with the values of discharge coefficient obtained with each of the above methods, the expression proposed by Simmons may also be employed.

$$C_D=1-\frac{4(\log_e 2)\sqrt{\frac{2}{1-\log_e 2}}}{\sqrt{Re_{D_2}}}\cdot\sqrt{\frac{l}{D}+\frac{l^2}{4D}}$$
$$. \quad . \quad . \quad . \quad (9)$$

This latter expression was obtained by an approximate solution of the momentum equation for incompressible laminar flow in which certain simplifying assumptions were made.

Results

The comparative results, averaged for a number of tests, are as follows :

Compressible flow :	Incompressible flow :
p_1—30 lb per square inch abs.	44·6 lb per square inch abs.
T_1—424 deg. Fah.	422 deg. Fah.
p_2—Sub-critical	—
p_1-p_2—	2·22in Hg
Re_{D_2}—3·72 x 10⁵	1·54 x 10⁵
C_D—0·968 (St. Venant-Wantzel, equation (5))	0·976 (St. Venant-Wantzel, equation (5))
0·987 (Boundary Layer Theory, equation (2))	0·987 (Boundary Layer Theory, equation (2))
0·961 (from Tabulated Properties)	—
0·990 (Simmons)	0·985 (Simmons)
C_D— (Using water)	0·987
Re_{D_2}—	1·665 x 10⁵

Magnitude of Probable Experimental Errors

As the several differences in the above results are small it is pertinent to inquire into the probable extent of the errors that could arise in reading the experimental quantities.

The upstream pressure, p_1, was indicated on a large bourdon gauge calibrated against a dead weight tester. It is thought that this gauge could be read to ±0·1 lb per square inch. A calculation indicates that an error of 1 per cent in p_1 would influence the discharge by ¼ per cent for the compressible case. The incompressible case would be virtually unaffected.

The error in the measurement of T_1 is negligible.

For the incompressible case the most plausible source of error lies in the observation of the mercury manometer. The accuracy of reading was thought to be at least 0·05in and an error of this magnitude may be shown to influence the flow by about 1 per cent. This gauge was subject to continuous observation.

It is believed that the error in weighing the discharge is negligible.

Discussion of Results

It is apparent that the agreement between the different methods of calculating C_D is fairly satisfactory for the case of incompressible flow, but rather less satisfactory for the

case of compressible flow. The disparity in the latter case may be attributed to a number of possible sources: (*a*) The discharge as calculated by the St. Venant-Wantzel equation (5), is somewhat insensitive to the value of γ. Nevertheless, the value of γ defined by the terminal conditions is 1·317 as compared with the commonly accepted value of 1·3 for superheated steam. The objection may also be made that the expansion is insufficiently far removed from saturation conditions to justify the use of equation (5).

(*b*) The velocity U_2 and volume v_2 of the issuing steam required for equation (6) may be in error to the extent of the uncertainties in the tabulated values of the properties of steam. Thus the tolerance on the accepted value of enthalpy[22] at the conditions employed is about $\pm 1 \cdot 5$ B.Th.U. per pound. A cumulative maximum error for the end points of 3·0 B.Th.U. per pound is thus possible. representing a 5·5 per cent error in the isentropic heat drop. The corresponding percentage error in U_2 and, therefore, in the discharge is 2·7. Similarly, the tolerance on the accepted value of volume is $\pm 0 \cdot 04$ cubic foot per pound allowing a percentage error in the discharge of 0·14. Whilst the latter error is negligible, the former may be very significant.

(*c*) The quantities ρ_0 and U_0 for use in the momentum equation are appropriate to isentropic flow in the main stream and no cognisance is, therefore, taken of the effect of reheating on these quantities.

The following additional points arise in connection with the boundary layer growth calculations.

No allowance has been made for the large curvature in diametral planes of the streamlines in the convergent part of the nozzle. The pressure, velocity and density gradients which should properly be used in the momentum equation (2) are those at the edge of the boundary and they differ from the gradients calculated using the one-dimensional theory. For the sharply curved flow of the present investigation the occurrence of a local adverse pressure gradient at the boundary near the end of the convergent section would give rise to a further thickening of the boundary layer and probably a reduction in discharge coefficient.

It has been assumed that the index of the power law defining the velocity profile is constant throughout the expansion at 1/7, but in fact the index decreases as the expansion proceeds.

It is interesting to observe that Simmons' analysis, which was for laminar flow, showed such close agreement with the present analysis based on equations (2) and (3) for turbulent flow. It is also noteworthy that the present work employing a compressible fluid showed such close harmony with results based on equation (9) which was developed from incompressible flow theory and the assumption of a different law defining the velocity profile. In his paper Simmons presented an experimental curve obtained using a water nozzle[23] in support of his analysis. The present authors thought it valuable to make a similar check on their own nozzle using water and the mean of some thirty-six tests is quoted above.

Concerning the viscosity of steam there are three schools of thought following respectively Sigwart, whose equation (4) has been employed here, Hawkins, Solberg and Potter[24] and Timrot and Vargaftik.[25] At low pressures the divergences between their respective results are small. The viscosity of steam is not a significant factor in the calculations, and its value was assessed using the local free steam temperature for T_0 in equation (4).

Conclusion

The results indicate that for incompressible flow the value of the discharge coefficient calculated using boundary layer theory is in good agreement with the values obtained by other methods. For compressible flow the position is less satisfactory, but sufficiently encouraging to merit further investigation.

Acknowledgments

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Chillerton Down Television Station, Isle of Wight

THE Independent Television Authority's new transmitting station at Chillerton Down, Isle of Wight, is due to start regular programme service to-morrow, August 30, serving about 2,750,000 people in the area between Weymouth, Newbury and Brighton, including about 1,000,000 people in fringe areas. This station will be the seventh built by the Independent Television Authority and the I.T.A. service area now includes 80 per cent of the population.

Some interesting innovations are to be seen in the Chillerton Down transmitting station. The vision transmitters are of a new design in which the number of valves has been greatly reduced and the cooling system has been simplified, under-floor ducting being dispensed with. After cooling the valves the air is extracted and discharged to reinforce the heating in the transmitter room (illustrated here), if required. The aerial, mounted on a 750ft triangular mast, is a twin-eight stack array (illustrated) which in this installation is used as a sixteen-stack. It gives directional radiation with a minimum of back-radiation southwards across the English Channel, the maximum radiation extending in an arc across the south coast of England. The aerial gain is of the order of 16 dB in the forward direction over an arc of 180 deg. It is proposed to use one pair of vision and sound transmitters as "main," with the other pair as "stand-by," so that the aerial, fed by a vision output of 4kW (and allowing for feeder losses), provides a vision E.R.P. (effective radiated power) of about 100kW over the 180 deg. arc. The feeder cable between the transmitter and the aerial is supported flexibly by runners and springs so that expansion can take place without any significant stress along the length of the run, and without recourse to expansion joints.

The vision transmitter is a 4kW Marconi BD366, band-III equipment of simplified design and layout so that it can be maintained by relatively unskilled labour if required. It is designed to be capable of handling colour or black-and-white transmissions to either 405, 525 or 625 line standards. An alternative version for completely unattended working is available.

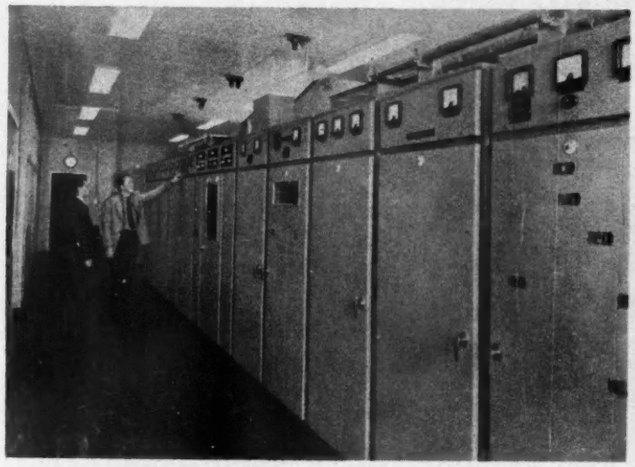
The transmitter is housed in three standard cabinets which stand side by side to form a continuous front of only 7ft 6in, the depth being 3ft 9in. Viewed from the front, the right-hand cabinet contains the r.f. stages and the final stages of the modulator, with the cooling fan in a lower compartment. The central cabinet houses the low-power units, while the left-hand cabinet houses the main and auxiliary h.t. rectifiers and miniature circuit breakers. "Switching on" procedure is determined entirely by these circuit breakers and by only two contactors, which provide the necessary interlocks to ensure the correct sequence of operation, and give overload protection. In the unattended version, two additional contactors provide for switching on the transmitter from a remote point. All doors and units giving access to high voltages are interlocked by keys in conjunction with an earthing switch to safeguard the operating personnel.

In the BD366 transmitter the kind of crystal drive used depends upon the user's requirements; it can be mounted in the centre cabinet or externally, as convenient.

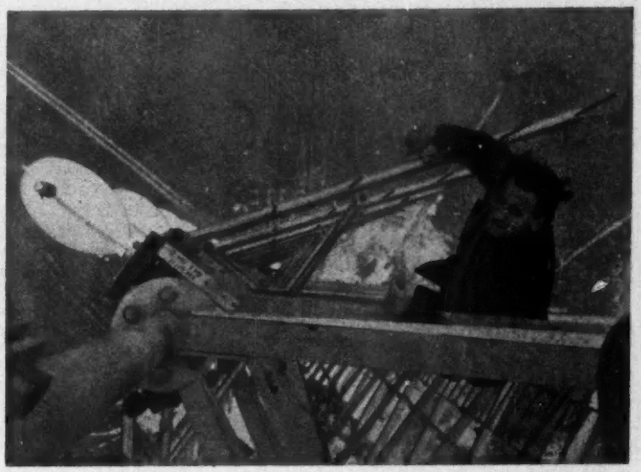
The drive output feeds into a single tetrode valve stage (QQV.0640) which operates as a tripler, and feeds an r.f. stage which is a tetrode valve (QV1-150A). The output of this tetrode drives the penultimate stage, which consists of four tetrode valves (QV1-150A's) in parallel push-pull. The circuits linking the penultimate r.f. stage to the final r.f. stage are designed to give a wide band width. The final r.f. stage uses two CR-1100 tetrode valves in push-pull. The tank circuit for this stage has been combined with a vestigial sideband filter which shapes the response to give appreciable cut-off for the vestigial sideband, thus avoiding the use of an external filter, except in cases where C.C.I.R. standards are involved. For ease of tuning and maintenance, the tuned circuits are of open-line construction.

The low-power stages are enclosed in the central cabinet and mounted on a sub-modulator chassis which contains the facilities for stretching synchronising signals and for linearity correction in the picture region. Stability of black level is ensured by the use of overall feed back and of noise-immune clamps in the sub-modulator. An inverter stage contained in the central cabinet provides for either a positive or negative-going modulation output from the sub-modulator. In the right-hand cabinet there are the modulator voltage amplifier, which consists of two tetrode valves (EL-34) and the cathode follower stage which uses three QV1-150A valves. The modulation output is applied to the grid circuit of the final r.f. amplifier.

The main h.t. supply to the final r.f. amplifier anodes is provided by six xenon-filled valve rectifiers. The final r.f. amplifier screens and the anodes of the penultimate and first r.f. amplifier stages are fed from a further six xenon-filled rectifiers. The screens of the penultimate and first r.f. stages derive their h.t. supply from the same source, via a potential divider. The tripler anode and screen are fed from a metal rectifier.



Part of the transmitter room at Chillerton Down. The transmitter cooling system requires no under-floor ducting. The Marconi "BD366," 4kW vision transmitter is designed to handle colour or black and white transmissions to 405, 525 or 625 line standards and to be simple to operate and maintain



Part of the dipole structure viewed from the top of the 750ft mast with anti-ice fairings on the left. Radiation from the sixteen-stack array is directional with an aerial gain of 16dB in the forward direction, giving an effective radiated power of about 100kW over a 180 deg. arc

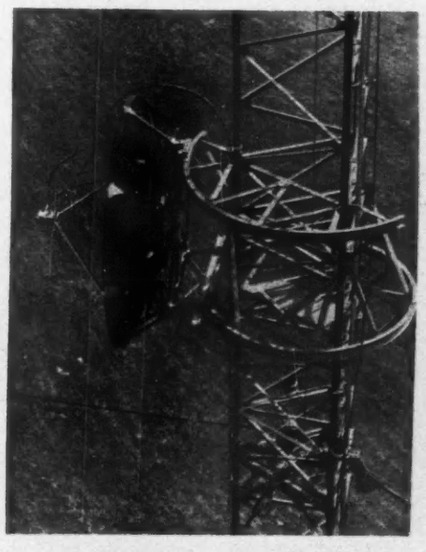
The sub-modulator h.t. supply is derived from a regulated power supply unit, while the anodes of the modulated amplifier and its associated cathode-follower stage are fed from another xenon-filled rectifier. The screen voltages of these stages are stabilised.

Main Particulars of BD366 Vision Transmitter

Power output	4kW peak
Frequency range	Band III (170-224 Mc/s)
Modulation system	Positive modulation—405 lines Negative modulation—525 lines Negative modulation—625 lines
Colour	Transmitter basically suitable for N.T.S.C. colour transmission
Video input voltage	1V double amplitude peak composite signal
Method of modulation	Amplitude modulation at grids of final r.f. stage
Modulation capability	Monochrome and 405 lines colour: Full picture excursion up to 2·7 Mc/s ; above that, amplitude inversely proportional to frequency 525 and 625 lines colour : Full picture excursion up to 4·5 Mc/s ; above that, amplitude inversely proportional to frequency
Power supply	Three phase, 4 wire, 380-440V, 50-60 c/s.
Power consumption	About 14kW at 0·9 power factor
Ambient temperature	0 to 40 deg. Cent.
Approximate weight	4000 lb (1815kg)
Dimensions	Height 7ft Width 7ft 6in Depth 3ft 9in

The complete transmitting equipment, including the feeder and aerial systems, was supplied by Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex. The installation includes two 4kW band-III vision transmitters (BD366), two 1kW band-III sound transmitters (BD270A), combining units, programme input equipment (vision and sound), monitoring equipment, flying-spot caption scanner, disc reproducer and microphone, test-gear and spares.

Programmes will be carried to the I.T.A. transmitter at Chillerton Down, I.O.W., over a link provided and operated by the Post Office. This link is in two parts. One will carry the I.T.A. national network programme from London to the Southern Television Plaza Studio at Southampton. The other will carry the network programme, locally provided programmes and advertising material inserted at the Plaza Studio, to the I.T.A. transmitter at Chillerton Down. The link will be some 125 miles in length, most of which will be provided by microwave radio relays. Short connections between Rowridge and Chillerton Down, and between Southampton telephone exchange and the Plaza Studio, will employ co-axial cables. Television signals will be transmitted by radio from the Museum telephone exchange in London to Rowridge, I.O.W. A new 30ft aerial has been erected on the roof of the Southampton telephone exchange for the radio link to Chillerton Down. The London to Southampton system comprises : (1) a two-hop microwave radio-relay link, of 83 miles length, operating in the 4000 Mc/s frequency band and installed on the existing route from Museum telephone exchange, London, via a repeater station at Golden Pot, near Alton, Hants, to the receiving terminal situated in the B.B.C. Television broadcasting station at Rowridge, Isle of Wight ; (2) a video link of 3½ miles length on coaxial cable from Rowridge to the I.T.A. station at Chillerton Down ; (3) a single-hop microwave radio-relay link, of 18 miles in length, operating in the 2000 Mc/s frequency band, from the I.T.A. station at Chillerton Down to the Post Office telephone exchange in Southampton ; (4) a video link of 1½ miles length on coaxial cable from the Southampton telephone exchange to the Plaza Studio. The Southampton to Chillerton Down system comprises : (1) a video link of 1½ miles length on coaxial cable from the Plaza Studio to Southampton telephone exchange ; (2) a single-hop 2000 Mc/s microwave radio-relay link, of 18 miles length, from Southampton exchange to Chillerton Down.



Post Office dish aerial on the I.T.A. mast at Chillerton Down

To guard against interruption by failures during programme time, the equipment, with the exception of aerials, is duplicated throughout to provide two independent signal paths.

The 4000 Mc/s radio equipment serving the Museum–Golden Pot–Rowridge link was designed, manufactured and installed by the Radio Experimental Branch of the Post Office Engineering Department. At each transmitter the video signal is arranged to frequency-modulate an intermediate frequency carrier of 60 Mc/s which, in turn, phase-modulates a travelling-wave valve driven by a 4000 Mc/s carrier. A second travelling-wave valve further amplifies the microwave signal to produce an output power of about 1W. At each terminal receiver the microwave signal is translated to the 60 Mc/s intermediate frequency range by means of a crystal mixer. Amplification at this frequency is followed by demodulation to recover the video signal. At each repeater similar techniques are used except that the intermediate frequency signal, instead of being demodulated, is amplified and caused to remodulate the travelling-wave valve. The frequency of microwave carrier driving this valve differs by 72 Mc/s from that incoming to the repeater. Waveguide branching filters are used for combining the outputs of the transmitters and repeaters with those of the radio link provided on this route for the B.B.C. The inputs of the receivers and repeaters are combined in similar fashion. This enables the use of common aerials and aerial feeders for the I.T.A. and B.B.C. links. The aerials are paraboloid dishes, each of 10ft diameter and with waveguide feeders. The aerial at Museum Exchange is 70ft above roof level, at Golden Pot 200ft to 300ft above ground, at Rowridge 70ft up the B.B.C. mast.

The 2000 Mc/s radio equipment serving the links between Chillerton Down and Southampton was provided and installed by The General Electric Company, Ltd., Coventry, under Post Office contract. At each transmitter the video signal is arranged to frequency-modulate a 70 Mc/s intermediate frequency carrier which is amplified and then translated to 2000 Mc/s by means of a triode valve mixer. Amplification at this frequency is by use of triode valves in two stages, to produce an output power of about 2W. At each receiver the signal is translated to the 70 Mc/s intermediate frequency range by means of a crystal mixer ; and, after amplification, is demodulated to obtain the video signal. Coaxial type branching filters are used for combining the transmitter outputs at each station. The receiver inputs are combined in similar fashion. At each station two coaxial aerial feeders are used ; the one serving the transmitters and the other the receivers. The 12ft diameter paraboloid dish acts as a common aerial for transmitting and receiving. The feeders enter the launching units which illuminate the paraboloids so that the radio signals being sent and received at a station have orthogonal polarisation, thus avoiding interference between transmitters and receivers. The aerial at Southampton Exchange is 30ft above roof level and that at Chillerton Down is 160ft up the I.T.A. mast.

PRESSURE STERILISER.—The Food Machinery Division of Mitchell Engineering, Ltd., has manufactured for a Canadian canning company a continuous hydrostatic pressure steriliser. Known as the "Hydron," it is capable of cooking and sterilising about 800 cans of vegetables per minute. The maximum working temperature is 262 deg. Fah.

SHORTER REPORTS

Accident at Calder Hall

THE official report on the accident that occurred on June 28 in Calder Hall "B" power house (see THE ENGINEER, July 4, page 3), has now been issued by the United Kingdom Atomic Energy Authority. The summary of conclusions states that the coincident failure of the high-pressure governor valve and the high-pressure runaway stop valve to close automatically caused No. 5 turbo-generator to overspeed and ultimately to disintegrate. The cause of the jamming of the valves was the presence of fragments of chilled iron shot that had been carried into the valves by the steam system. The board of inquiry has not been able to find out how the substantial quantity of chilled iron shot entered the system, and expresses the opinion that this information is not essential to its conclusions. It is recommended that in order to avoid future accidents of this kind additional precautions should be taken to ensure that hard materials do not get into the system, and that the steam plant in the remainder of the station should be examined before commissioning to make sure that it is free from shot or other harmful material. It is thought that it would be desirable for future governor or runaway stop valves to have glands or spindles faced with material harder than anything that could "arise" in the system. The operation of the governor valves should be observed daily by reducing and restoring the alternator load in such a way as to show a significant movement of the valve spindle, and the runaway stop valves should be operated monthly by using the manual trip mechanism, after removing load from the alternator. When rapid shutting down of the generator is required for other than instant emergency, the board thinks that the load should be reduced from the electrical control room by means of the remote governor speed control at its maximum installed rate of operation, and that the turbine driver should be told of an impending shut-down. A strong wall is described as desirable between turbines and control rooms containing instruments essential for the reactor. The remaining recommendations made by the board in its report are: (*a*) the CO_2 gas main should be duplicated where it passes through the turbine house; (*b*) there should be a wall between the CO_2 tanks and the turbine house; (*c*) barriers should be installed in cable ducts and pipe trenches to prevent water from flowing from the turbine house to other parts of the plant; (*d*) drainage should be examined to make sure that water cannot "back up" into the cable ducts and machine pits; (*e*) the intakes to the air cooling system for the biological shield should be repositioned so that they cannot become immersed.

Aircraft Noise Limitation

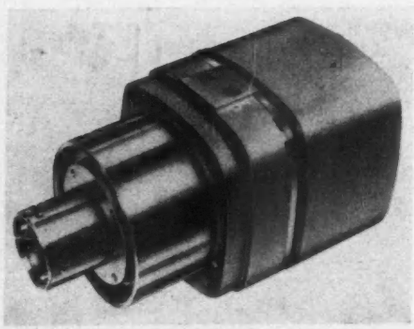
THE Minister of Transport and Civil Aviation has issued a statement on the noise allowable at airports in built-up areas. According to the statement, the technique of noise measurement has been standardised. Any aircraft, the noise of which is not "comparable with" that of commercial piston-engined transports (this is understood to mean any aircraft more noisy than those transports), will only be allowed to operate into United Kingdom airports under restrictions intended to minimise disturbance on the ground, but, apparently, the restrictions will be such as to admit machines which have been subjected to "every possible attempt to silence them." Accordingly, a flight by the Tu.104 into London Airport with the object of establishing operating techniques to avoid excessive noise would be welcomed. Aeroflot services to Western Europe may therefore include flights to Britain, and those of B.E.A. be extended to Moscow. An example of the restrictions that may apply is afforded by those under which Pan-American World Airways operate the Boeing 707-120 from New York International Airport, and under which they will also perform experimental and crew training flights at London Airport: (*a*) operation during "waking" hours; (*b*) in good weather only (presumably visual flight rules); (*c*) gross weight not more than 190,000 lb; (*d*) piloting techniques to be such as to minimise the "effect of" noise on the ground.

We are advised that there is no objective standard of acceptable aircraft noise, and it is expected that it will continue to be necessary for individual designs to seek the Minister's approval.

Actuator and Power Feed Device

AN electrically controlled device which can be adapted as either an actuator or a power feed unit has been recently introduced by Numation, Ltd., The Brackens, London Road, Ascot, Berks. In this device there is incorporated in a single unit an air power cylinder, a hydraulic control cylinder and a hydraulic valve mechanism which serves to stop, release or meter the flow of fluid from one side of the hydraulic system to the other and thereby control the energy of the air cylinder.

In the actuator construction the hydraulic mechanism is designed to arrest the traverse instantly against the full thrust of the air cylinder plus a rated margin to cover external inertia loads. Being double-acting the unit holds its position against forces applied from either direction. The hydraulic lock is self-sustaining in the absence of both air-line pressure and control current, so that the unit remains effective in the event of failure of the services.



Electrically controlled actuator or power feed device incorporating a pneumatic power cylinder and hydraulic control cylinder

The cylinder-head incorporates solenoid-operated controls for the air and hydraulic functions, together with a number of traverse-actuated switches which can be preset to "make" or "break" at any precise point in either direction of stroke.

The traverse switches may be wired into the circuit of either solenoid to provide preset directional or positional control. These switches may also be wired into external circuits for remote signalling of position, or for the interlocking actuation of other elements of the same plant. Where over-riding manual control of the power traverse by push-button is necessary the unit is capable of being "inched" in increments as low as 0·02in to 0·03in.

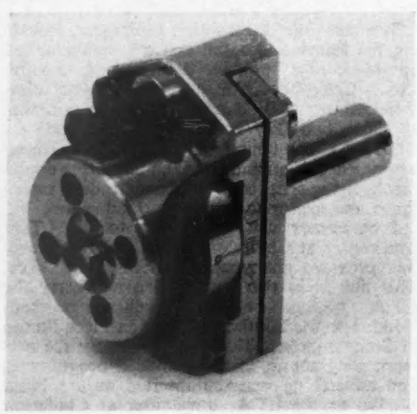
A typical actuator which is shown in the photograph above has a net thrust of 1000 lb using an air-line pressure of 80 lb per square inch, and a traverse time of 1–1½ seconds. The working stoke is 2½in, and the unit is designed for operating valves in a processing plant.

When used as a power feed device positive hydraulic locking is replaced by metered fluid flow so that a two-speed traverse is provided, the slower speed being finely adjustable. This version of the device is applicable to machine tools where the electrical arrangements can be adapted to give a machine a completely automatic cycle. Its traverse-actuated switches can also be used for the interlocking control of other elements of a machine. It is claimed that with such devices preset positions of speed change and reversal of traverse are repeated within a few thousandths of an inch.

Self-Opening Diehead

A NEW model "Coventry" diehead now being made by Alfred Herbert, Ltd., Coventry, has been specially designed for use on single-spindle automatics such as the Brown and Sharpe No. 00G, B.S.A. No. 48 and C.V.A. No. 8 machines. It will cut threads from 12 B.A. to ¼in Whitworth, and as it has a hollow shank, screws of any length can be cut. This style "XT" diehead, as it is named, is also equipped with external tripping mechanism which eliminates the possibility of its opening due to centrifugal force produced by the very rapid indexing of the turret on high-speed machines.

A particular advantage claimed for this tool is its ability to cut short threads, as it can be set to trip almost immediately the dies commence cutting. The diehead is fitted with a spring-cushioned shank which provides lateral movement in both directions to compensate for the slight difference which may exist between the pitch of the thread and the forward motion provided by the feed cam. This cushion-action ensures a good start to the thread and with the substantial sliding dogs, provides an easy sliding movement, ensuring long die life. The spring pressure can be varied.

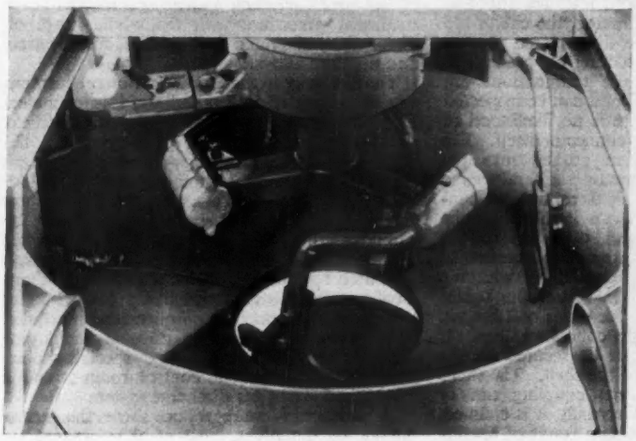


Self-opening diehead with external tripping mechanism, suitable for cutting threads from 12 B.A. to ¼in Whitworth

The diehead illustrated herewith uses the same dies as fitted to all ¼in "Coventry" dieheads, so that the standard die grinding fixture and height gauge can be used for regrinding. The dieheads can be used effectively on small capstan and centre lathes where the external tripping mechanism facilitates the cutting of short threads.

Pan Mixer for Concrete

A PAN mixer with a mixed batch capacity of 10 cubic feet is now being manufactured in this country, from a Continental design, by Millars' Machinery Company, Ltd., Thorley Works, Bishops Stortford, Herts. The machine is known as the "Universal" mixer, and is considered by the makers to give a very uniform mixing for a considerable variety of materials. For instance, mixtures for concrete, mortar or soil stabilisation can all be handled, and it is considered that when mixing concrete, for example, the efficiency of the mixing does not depend on the water content of the mix. For ordinary concretes, a mixing time of thirty seconds is stated to attain homogeneity of the mixture. Thus the short mixing time gives the machine a correspondingly high output.

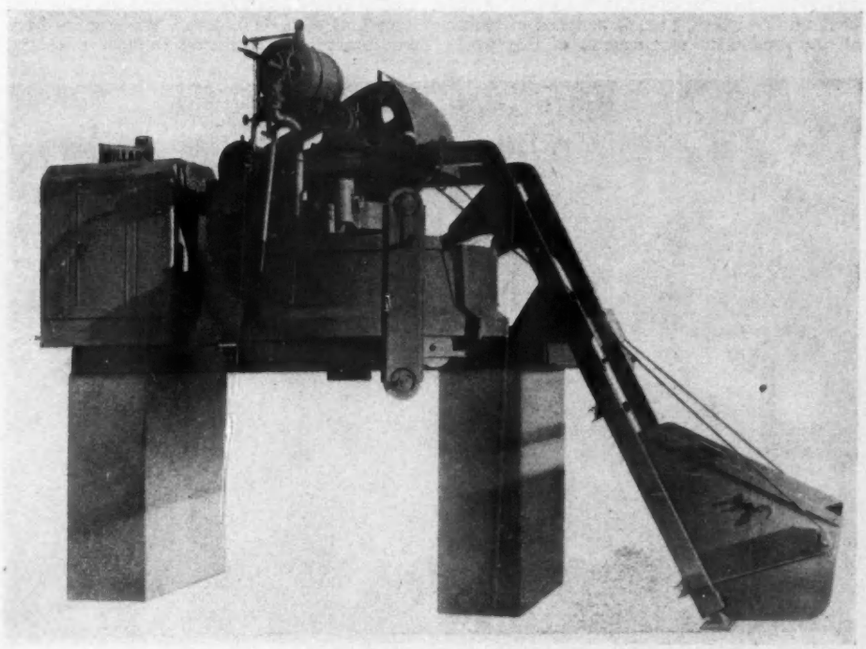


The mixing pan showing the three flexibly mounted mixing blades and wall and base scrapers. The discharge door is partly open

The two illustrations accompanying this article give a good idea of the machine. The pan rotates in a clockwise sense, and three mixing blades, mounted on a common shaft, rotate anti-clockwise. The shaft on which the blades are carried is eccentric to the pan, and the circle swept out by the three blades is roughly two-thirds of the diameter of the pan. The discharge door is at the centre of the pan; it is shown partly open in the illustration above, and it will be seen that the area swept by the blades, as indicated by the blade in the foreground, extends over the door and to the pan wall in the background. Note also a scraper blade on the right scraping the base of the pan, and one on the left scraping the wall.

The three rotating blades rub on the bottom of the pan. They have hardened tips, which can be renewed. Further, they are flexibly mounted and thus can deflect if some obstruction is met with in the mixer. The two scraper blades are also flexibly mounted. The pan rotates at 11 r.p.m., and the set of three blades rotates, in the opposite sense, at 48 r.p.m. A 12 h.p. Ruston engine powers the mixer; it runs at 1500 r.p.m., with a 2 : 1 reduction gear, giving a take-off shaft speed of 750 r.p.m. There is then a centrifugal clutch, and a chain drive to the mixer input shaft, where a train of bevel and spur gears give the operating speeds quoted above at the mixing blade shaft and the pan. The pan is driven through a gear ring, which is under the guard which can be seen at the base of the pan in the illustration below; note also the rollers carrying the pan. The hand crank, which can be seen in this illustration, operates the discharge door in the base of the pan; the loading bucket and its operation will also be clear from this illustration. Water is supplied from a 14-gallon tank, also shown.

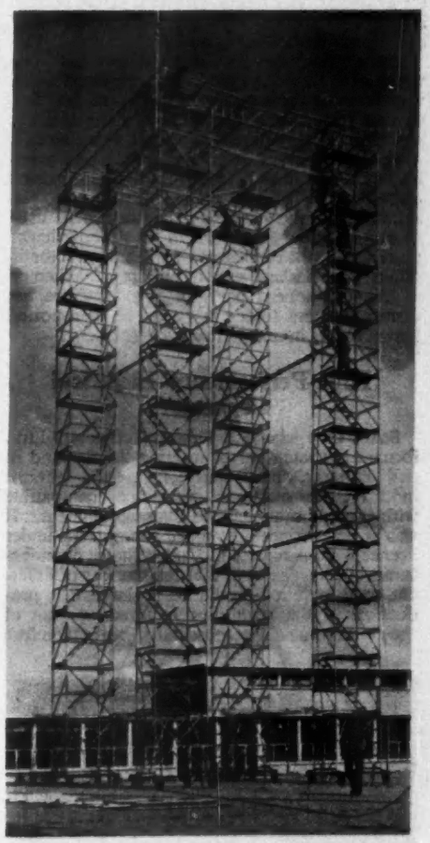
The pan of the mixer is fabricated, other major components being fabricated or cast. The weight of the machine is 3 tons 5 cwt. An electric motor may be used as an alternative source of power, and a mobile version is in course of design.



This pan mixer gives a mixed quantity of 10 cubic feet of concrete. The mixing time is only thirty seconds

100ft-High Portable Mobile Tower

AN interesting application of the lightweight portable "Zip-up" design of staging manufactured by Access Equipment, Ltd., Maylands Avenue, Hemel Hempstead, Herts, was demonstrated by the firm last week. It will be recalled that in one form this staging comprises collapsible box-form frame assemblies which are built up of aluminium tubes. When the hinged frames are opened out to form a box staging frame they are held rigidly in position by side struts fitted with self-locking hook ends and a ladder section which provides a diagonal strut. Successive frames are locked one on top of the other by spigots which register in the mating tops and bottoms of the vertical side tubes. Stagings to suit special purposes can be built up quickly, without the use of tools, in different sizes and forms, using these frames and a variety of other light tubular members incorporating the basic automatic self-locking coupling hooks.



Four coupled towers for the 68ft high platform of a 30ft high mobile tower

The particular application of the staging demonstrated has been developed with the use of standard parts for the Dutch firm of Cemsto N.V., Amsterdam, which specialises in the cleaning and restoration of buildings. The structure is intended for use when cleaning and renovating the interiors of high buildings such as cathedrals, and the makers were called upon to supply a mobile tower 100ft high which would enable every part of the interior of a building to be reached. The main part of the structure can be seen in the photograph we reproduce, which was taken during initial erection trials.

This main structure comprises four 68ft towers built up of standard box-frame members and coupled together by struts and tensioned wire ropes. Each tower is carried on a mild steel base frame with rubber-tyred castors and fitted with jacking screws which are lowered to prevent movement when the structure is located in position. At the top of each tower a tubular frame carries a central rubber spherical mounting. Bridging struts, assembled to form a main cross frame at the top of the towers, are supported through cups on the four tower mountings. Projecting from the tops of the top frame struts are short pins on which holes drilled in ½in thick plywood flooring sections register. This method of pinning the floor sections on the struts adds to the rigidity of the main structure.

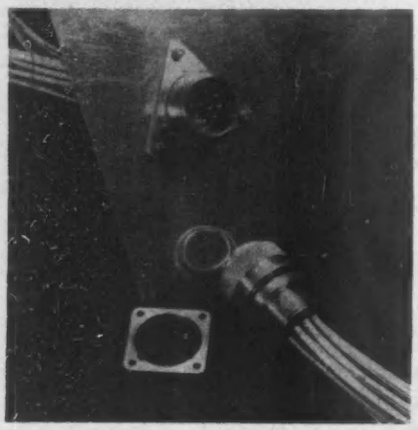
The tower structure provides a 729 square feet working platform capable of taking a

distributed load of 1 ton or 150 lb per square foot. The platform is fitted with guard rails all round and it is used as a working floor for a 30ft high mobile tower which is also built up of standard stairway frame members. This upper tower is mounted on lockable castors and it can be manœuvred over the whole of the platform as required. When necessary, the whole tower assembly can be readily lowered from its jacks and moved by eight men to other working positions in a building. As the upper, or mobile, tower weighs only 450 lb, an ample safety margin is provided for supporting cleaning and other equipment on the main platform.

The eleven "Zip-up" stairway sections from which each tower is built have a plywood walkway between the respective stair heads and feet so that men can safely ascend and descend the structure. During erection and dismantling of a tower, a pole crane is clipped on the side members of the topmost frame to facilitate the raising and lowering of the parts. If required, the standard members of the structure can be used in any required combination to suit particular classes of work carried out by the contractor in different shapes and sizes of buildings. When all of the component parts of this structure are dismantled and folded they can be transported between sites in one pantechnicon only.

High-Performance Electrical Connectors

SOME time ago the Plessey Company, Ltd., formed the intention of meeting the demand in this country, particularly from the aircraft industry, for electrical connectors compatible with contemporary United States equipment. It was at first proposed to make components under licence from a successful United States manufacturer, but it was found that the number of different parts required would be so large that production in the quantities required was out of the question. The possibility was therefore examined of designing a connector interchangeable with both AN (Army/Navy) and MS (Military Specification) plugs and sockets, but with a quality so high that it would satisfy all the different performance requirements relevant to such equipment. By the use of a silicone rubber, having mechanical, chemical and electrical properties of a high order, for the moulded body of the connector, it has been found practicable to achieve this, and the result will shortly be available as the "U.K.–AN" range of electrical connectors. They meet the requirements not only of specification Mil. C-5015-C. but also of the Ministry of Supply EL1884 for aircraft use and Radio Component Specification 321; accordingly, it is hoped that they will prove valuable for N.A.T.O. equipment, and it is already intended that they shall be standard on British fighting vehicles. The "free" part of the connector replaces both the plugs AN 3106 and AN 3108 while the "fixed" part replaces the three sockets AN 3100, AN 3101, and AN 3102; since the performance is adequate to match all the types A, B, C, D, E (environment resistant) and K (fireproof), for any particular arrangement of conductors two items in store suffice in place of thirty (five times six). The numbers of parts in a completely provisioned inventory would, we are advised, be about 13,200 and 800 for AN and U.K.–AN respectively.



Each half connector consists essentially of a silicone rubber moulding bonded into an aluminium shell

The design of the new connectors is unusual in that the plug pins and socket inserts are not permanently attached to the two halves of the connector; on the contrary, they are supplied loose. To assemble a connector, the cables are each fitted with one of the silver-plated pins or inserts as necessary, by soldering or, preferably, by crimping; since all the terminations are separate at this stage, each joint can be inspected without difficulty, and there is no likelihood of solder or flux entering the connector itself. The terminated cables are then pushed into the moulded body of the connector; a hand tool is available for use in the field to fit one conductor at a time. The cable itself enters the moulding to a depth of several diameters, so that forces applied to the wire are not transmitted to the terminal—this feature does away with the need for any accessories to secure the cables mechanically; a force of the order of 30 lb wt. is needed to pull a single conductor free. If screening is needed it can be secured to the male thread on the back of the shell. The shells are of aluminium, and the coupling nut of aluminium bronze, with the result, it is claimed, that seizing of the threads as a result of heating is not experienced. The female part can be sealed on to a bulkhead or provided with one of two removable flanges; the socket inserts or plug pins can be in either half.

As has been stated, these connectors qualify widely for military employment, but for the benefit of those interested in commercial applications it may be retailed that the tests satisfied include functioning between −65 deg. and +190 deg. Cent., resistance to 1100 deg. Cent. flame for fifteen minutes while carrying rated current, immunity to salt water and kerosene, air leakage through and round installed connector to be less than 1 cubic centimetre per hour at 20 lb per square inch, and leakage less than 1 microampere for 5kV at sea level or 2kV at a pressure equivalent to 70,000ft. The connectors are available in five contact sizes with current ratings of 12, 24, 50, 100 and 170A respectively for temperature rise below 40 deg. Cent. for fully wired plug and socket.

Heat-Treatment Plant

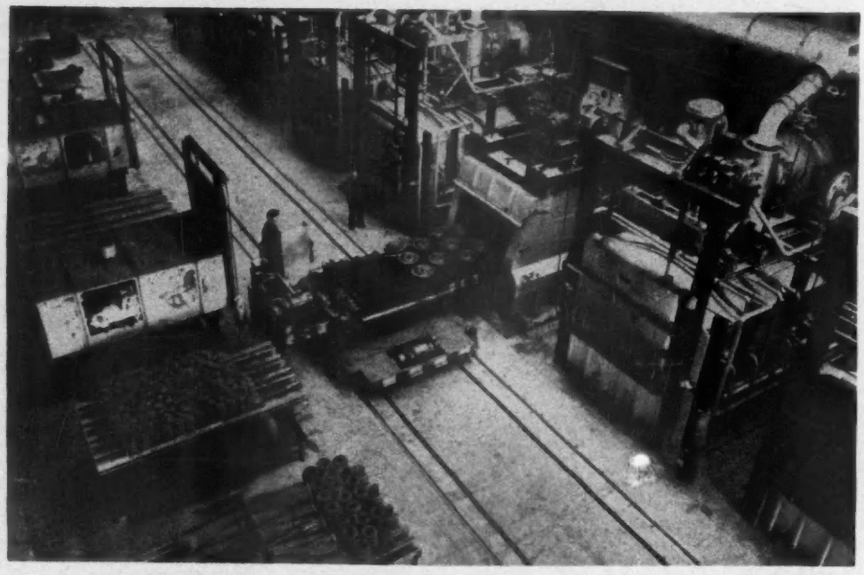
A NEW central heat-treatment plant placed in service at the Darley Dale works of Firth-Derihon Stampings, Ltd., is designed to handle all the production requirements of that works and the firm's Tinsley works. It has enabled a reduction of some 50 per cent to be made in the labour force and the new plant has a quarter of the number of furnaces to those previously used in operation. The plant replaces a producer-gas-fired forge reheating and small batch heat-treatment furnace installation used satisfactorily at the Darley Dale works up till 1956. Then it was decided to change over to the use of town gas and modernise the furnace equipment in view of the need for much greater accuracy in heat-treatment procedure with the whole range of high-quality alloy and carbon steels, nickel-based and titanium alloys.

The first stage in the modernisation programme was the laying of a 12 mile long, 15in diameter, high-pressure town gas main from Chesterfield via Matlock to the Darley Dale works; the installation of a new high-capacity town gas meter and governor house; and extensive modification of the internal distribution gas main. The new plant was designed jointly by Gibbons Brothers, Ltd.; Honeywell Brown, Ltd.; Hartons, Ltd.; and members of the Brown-Firth Research Laboratory. It includes three Gibbons dual-system treatment furnaces; two Gibbons tempering furnaces; an oil quenching machine; a Gibbons-Van Marle turntable charging machine; loading tables and special cooling tables; an instrument control room; and a centralised waste gas discharge system.

A photograph we reproduce shows the general layout of the plant. All of the furnaces are 11ft long, 6ft 6in wide, and have a height of 3ft 3in to spring line of arch in the doorways. Furnace loads up to 5 tons weight are handled. These dual-system furnaces have normal operating temperature ranges of 200 deg. to 750 deg. Cent., with forced recirculation, and 750 deg. to 1250 deg. Cent. without forced recirculation. The tempering furnaces have normal operating temperature ranges of 200 deg. to 750 deg. Cent. with forced recirculation.

All furnace temperatures are electronically controlled by a fully automatic electro-pneumatic system for which the Honeywell-Brown control instruments are housed in a centrally positioned air-conditioned instrument control room. The tempering furnaces are two-zone controlled and the dual-system furnaces single-zone controlled. Temperature distribution throughout the furnaces is held to extremely fine limits and is indicated and recorded at any six points in each furnace.

All of the furnaces are fully instrumented and controlled to safeguard against failure for any reason. Compressed air for the pneumatic control equipment is supplied from duplex air compressors and receivers controlled from the instrument room. Kent gas-flow recorders are used to record gas-flow rates, and total gas consumptions of each furnace. Waste gases from the furnaces are collected through a central



General layout of heat-treatment plant, showing the rotating charging machine withdrawing a batch of turbine discs from the oil quench machine

overhead main and discharged into the atmosphere by a high-capacity exhaust fan into a chimney stack.

The oil quenching machine, of fully enclosed construction, has automatic door operation. It incorporates means for automatic lowering and lifting of loads and for variable, controlled oscillation of the load during the quench period. For cooling the oil in this machine, the oil is drawn from the top of the tank, passed through a water-cooled cooler, and returned by distribution ducts in the tank base. The oil cooler is capable of dealing with 27,000 gallons of oil per hour, using 12,000 gallons of water per hour.

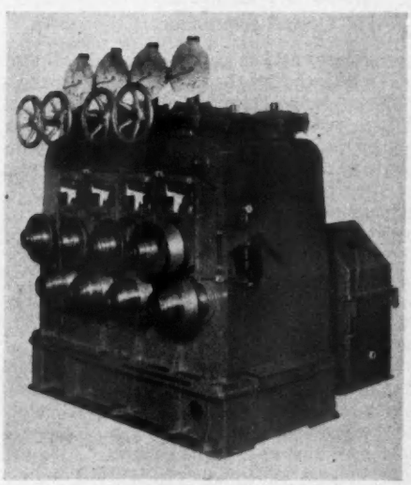
The charging machine used in conjunction with the loading tables, furnaces and oil quench machine is of four-arm turntable design, and accommodates 5-ton loads. It is electrically operated and has four motors for the individual hoisting, lowering, charging and discharging, traversing and rotation motions. Power is supplied to the machine via a motorised cable drum unit, mounted on the charging machine, the feed cable being laid down in a small duct below floor level.

The general plant layout has been designed for the efficient handling of large and small batches and to eliminate manual handling, as the plant has to deal with forgings varying in weight from a few ounces up to about 800 lb. All incoming forgings are delivered into a reception bay in stillages by forklift trucks. Battery-operated stillage trucks are used for the movement of all loads in the storage area and between the storage area and the loading tables ; after treatment the trucks move loads to an adjacent inspection department. In the main heat-treatment bay, electric overhead cranes are used for assembling the heavier forgings on the loading tables, &c. Dependent on the weight and section of the forgings to be treated they are loaded either into special heat-resisting furnace trays or on to heat-resisting bearer bars. After a load has been assembled on the loading table it operates as a unit throughout all subsequent operations in the heat-treatment department.

Roller Straightening Machine for Sections

AN eight-roll roller straightening machine made by the Bronx Engineering Company, Ltd., Lye, near Stourbridge, which is illustrated below, is capable of handling mild steel angles from 1¼in up to 3in by 3in by ½in, squares from ½in up to 1¾in, and other mild steel sections of equivalent modulus. The machine has a main housing of welded steel construction, with the wearing plates and bush shells welded in position before machining. The main 35 h.p. motor is fitted with reversing control gear and drives a two-speed change gear unit giving operating speeds of 100ft and 180ft per minute.

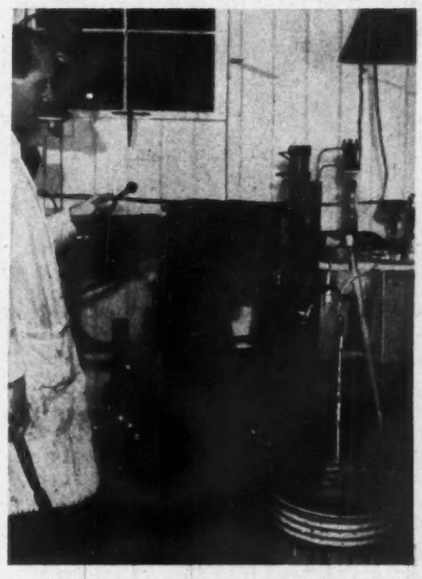
The top four rolls have means of individual adjustment vertically and horizontally, vertical adjustments being made through the hand-wheels to be seen in front of the machine. Horizontal adjustments are made at the rear of the machine and clear indicators are provided to show the roll settings.



Eight-roll roller straightening machine for sections

Hollow Pressure Die Casting Without Cores

A NUMBER of advantages are claimed for a new method of producing hollow pressure die castings without the use of internal cores, which has been developed by Robar Products, Ltd., 39, Park Street, London, W.1. In this process the molten metal is injected into the die cavity in the usual way and when a predetermined wall thickness has solidified the excess molten metal is withdrawn by a partial vacuum created by the retraction of the injection plunger. This withdrawal of the molten inner mass of metal leaves a clean hollow casting with a wall of any required thickness. It enables shorter cycle times to be worked than normal with orthodox processes, eliminates need for complicated dies with retracting cores, and enables the ready manufacture of many forms of hollow castings not hitherto possible with pressure die casting machines.



Machine for making hollow pressure die castings without the use of cores

In order to achieve the rapid cooling of the injected metal the dies are water cooled to maintain them at a much lower temperature than is usual with pressure die casting. In addition to enabling short cycle times to be used this cooling makes possible a relatively short " dwell " time for the metal in the die and reduces the corrosive effect of the molten metal on the die cavity wall. For this reason special steels need not be used for the manufacture of the dies, and tests have shown that ordinary mild steel dies have a long effective life. It is stated that with the process hollow castings with a wall thickness as low as 0·005in to 0·010in can be produced, but in such cases there is possibility of wall collapse owing to atmospheric pressure when the plunger is withdrawn to evacuate the casting. Normally, wall thicknesses below 0·050in are not recommended for strength reasons.

The first production machine developed for this die casting process has been in operation for some time and it can be seen in the accompanying illustration. It is generally of a simple conventional design, operated by compressed air throughout, and it is controlled by a system of air valves which can be set to give the required sequence of machine movements and cycle times This pneumatic control equipment is housed in a separate cabinet and connected to the machine through eight air lines. Die cooling is effected by a flexible connection to a normal domestic water supply.

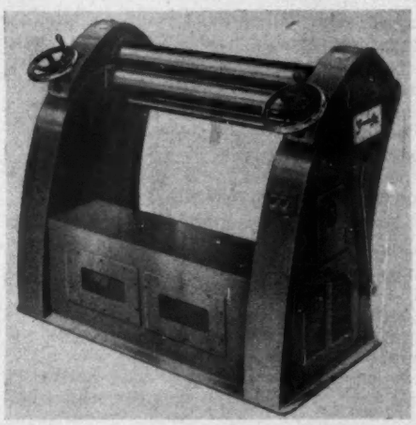
The moving platen is actuated by a toggle mechanism operated by a pneumatic cylinder. In the sequence of operations molten metal flows by gravity from the pot to a sleeve which is situated in line with the injection cylinder. A valve in this supply line cuts off communication between the sleeve and the pot before the injection stroke takes place. When injection has been completed the plunger is retracted after the necessary dwell period and evacuates the molten metal in the casting into the sleeve. This metal in the sleeve is maintained in a molten condition so that when the supply valve to the pot is opened at the start of the next cycle, the sleeve has only to be " topped up."

When it is required to produce castings having higher quality surface finish than usual, provision has been made in the automatic sequence for evacuating the die cavity immediately before the metal is injected. Such castings have dense surfaces which can be easily polished for plating if required. If a casting with an increased wall thickness on one side is required, this can be achieved by introducing a short pause during the evacuation period. This allows more metal to adhere to the side of the cavity at which evacuation is being effected.

Hydraulically Driven Bending Rolls

PARTICULARS have been received from John S. Young and Co., Ltd., Maryville Avenue, Giffnock, Glasgow, of a hydraulically driven bending roll which is now being made to handle a range of mild steel plates from 39in wide by ¼in thick to 12in wide by ½in thick. This machine, of steel construction, is seen in the accompanying illustration, and is designed for ease and safety in operation. The drive is totally enclosed in the base, and the arrangement of the rolls off-centre towards the rear of the machine gives the operator ease of access to the workpiece, with ample clearance between the rear bottom roll and the floor.

The machine, known as the " Genelin " model, is fitted with a 4¾in diameter top roll and 4in diameter bottom rolls, 39½in long. Top roll settings are made with individual end screws through handwheels, and the pointers and scales used at each end to indicate roll position facilitate parallel setting. When bending cylinders or rings on the machine, either end of the top roll can be released for removal of the work. All of the rolls are mounted on " Skefko " spherical roller bearings.



Bending rolls with stepless range of speeds forward and reverse up to 100ft per minute. It handles mild steel plates from 39in wide by ¼in thick to 12in wide by ½in thick

The machine is driven by a 5 h.p., 1500 r.p.m. motor, directly coupled to a " Churchill-Sturm " hydraulic drive unit, from which the power is transmitted by a duplex chain and gearing to the bottom roll assemblies. With this design of hydraulic drive unit there is made available a steplessly variable range of roll speeds up to 100ft per minute in each direction. The roll speed is controlled by duplicated levers at each end of the machine, and the instantly reversible drive ensures speed and safety in operation.

Industrial and Labour Notes

Problems of Re-Expansion

The second report of the Council on Prices, Productivity and Incomes was published on Monday (H.M. Stationery Office, 2s.). For the most part, it is a review of economic trends during the period which has elapsed since the appearance of the first report in February.

There is, however, one chapter of the report entitled "Prospects for the Near Future," and therein the Council discusses some of the problems of a re-expanding economy. It is pointed out that for the past three years the growth of real national output has been very slow and that production by industry alone has not grown at all over the period as a whole. Yet, the report comments, these have been years of exceptionally high industrial investment. The Council goes on to say that the indications of the economic future suggest that the next few months are more likely to witness a decline of activity than an increase. All the main components of expenditure promise either to be stable or to fall, but the Council says it has found no suggestion that the fall will be anything but gradual. On the other hand, the Council realises that a recession of demand can have cumulative effects through discouraging business investment in stocks and fixed capital, so that "a steepening of the pace of decline cannot be ruled out." With the industrial capacity of the country already somewhat under-employed, the report observes, and likely to be still less fully employed, it is natural to consider whether the Government should not act so as to encourage a revival of demand. The partial reversal of the restrictive measures imposed last autumn is then discussed, but, the report continues, "it is not clear whether this in itself will give sufficient encouragement to the spirit of business confidence on which private investment depends."

In its summing up of the situation, the Council says that the dangers of inflation have only been "scotched," not killed, by the slackening of tempo in the last twelve months. It must not be supposed, the report remarks, that the problem of getting the growth of incomes into line with that of productivity has been solved, merely because in the year 1958 increases in income look like being distinctly lower than in previous years. The balance of payments is in a healthy state and foreign exchange reserves have been rising very satisfactorily, but the Council points out that "neither of these conditions is bound to last." Past experience, it is added, suggests that any substantial revival of demand may well be accompanied by renewed threats to price stability, to the balance of payments and to the gold and dollar reserves. In these circumstances, the Council concludes, it seems clear that while it is right that policy should aim at an expansion of demand, it must proceed gradually and with caution towards that end. The dangers of recession are not so drastic and so imminent, nor those of inflation so remote, as to justify a policy of all-out encouragement of expenditure. The choice of particular measures involves considerations of timing and selection into which the Council does not feel "it would be appropriate to enter." But it does, however, "endorse the general attitude and approach which seem to have inspired recent policy decisions."

Coal

Coal output in the thirty-four weeks of this year, ended last Saturday, was approximately 6,500,000 tons below that achieved in the comparable period of 1957. Production losses through recognised holidays were much the same in the two periods, but the loss of deep-mined output through disputes has been a little lower this year than it was last. Total production this year, up to the end of last week, was 139,458,300 tons. The decline has been in deep-mined output which is now approximately 7,000,000 tons below the comparable figure for last year. Opencast production, totalling 9,195,300 tons for the thirty-four week period, shows a steady increase.

Colliery manpower has declined this year, the average weekly number on the books being 703,600 compared with 710,200 last year; the average weekly number of face-workers is given as 275,300, which is 3000 less than a year ago. Inland coal consumption, exports and bunker requirements have continued to fall. Together they took up 134,418,000 tons in the first thirty-three weeks of this year, which was 5,300,000 tons below the comparable figure for 1957. Total coal stocks, distributed and undistributed, were estimated at 29,756,000 tons on August 16.

Iron Castings

The Joint Iron Council has stated that owing to trading weaknesses in the building, steel and engineering industries, the production of iron castings declined during the second quarter of this year despite the continued firmness of the automobile industry. The total output was 887,000 tons, compared with 945,000 tons in the second quarter of 1957, a reduction of 6 per cent.

The Council says that, although the production of castings for the automobile industry in the second quarter of this year was lower than that of the first quarter, it still constituted a record for the second quarter of the year. The engineering section, however, continued to suffer from the effect of the reduced level of investment in plant and machinery, and reduced activity in the building industry has had a decidedly adverse effect on the ironfoundries. In the steel industry, production this year has been below last year's level, a factor which has noticeably reduced the demand for ingot moulds. But the output of castings for the railways continues to be sustained by the requirements of the railway modernisation programme.

The number of people employed in the ironfounding industry at the end of June, 1958, was 131,900. This indicated a reduction in the labour force of 3 per cent since the end of March.

Overseas Trade

The United Kingdom's overseas trade figures for July show that good progress was made in the task of recovering from the effects of the dock strike in June. The value of exports in July was £285,800,000, the highest monthly figure recorded this year. Re-exports were valued at £12,200,000, and imports at £337,800,000. The visible trade deficit dropped in July to £40,000,000, but that figure was still above the average for the first five months of the year.

The Board of Trade says that the recovery in exports during July was accounted for mainly by heavy shipments of engineering products. The Board adds that, in the first seven months of this year, compared with the same period of 1957, engineering exports came out a clear best with a rise of 5 per cent, in contrast to a fall of 4 per cent for exports as a whole. The increases in exports of cars and aircraft (29 and 65 per cent respectively) were outstanding. Although exports of many kinds of machinery have levelled off or even fallen somewhat this year, substantial increases in exports of aircraft engines, tractors and tractor parts brought a rise of 3 per cent in the total for the "machinery other than electric" division. Exports of electric machinery and ships and boats, however, were below last year's levels.

The Board of Trade has also stated that, in the second quarter of this year, the volume index of imports was 2 per cent below that of the first quarter and was 3 per cent below the level of the second quarter of 1957. Exports were 5 per cent lower in volume than in the first quarter of this year, the average for the first half of 1958 being 6 per cent below that for the comparable period of last year. Export prices remained unchanged during the second quarter and import prices were 10 per cent lower than in the second quarter of 1957.

Basic Materials Prices

The Board of Trade has stated that the basic materials index, which rose in June for the first time since March, 1957, fell again in July. The overall decrease of 0·3 per cent, which offset the increase in June, was brought about mainly by lower prices for raw wool, which, together with slight decreases in the prices of manganese and tungsten ore, lead and zinc, more than offset increases in the prices of raw rubber, copper and hides and skins. The price index numbers for materials used in the mechanical engineering and electrical machinery industries both rose by 0·2 per cent during July, owing to increases in the prices of some copper and brass items, rubber and tin. At the end of July the index numbers (1954=100) were 123·5 for materials and fuels used in the mechanical engineering industries, and 114·6 for materials and fuel used in the electrical machinery industry.

Fixed Capital Expenditure

Information collected by the Board of Trade indicates that fixed capital expenditure by manufacturing industry in Great Britain was, at current prices, 2 per cent higher during the first quarter of 1958 than a year earlier. This compares with a decrease of 1 per cent during the last quarter of 1957. Expenditure on plant and machinery showed a slightly larger increase over a year earlier than did expenditure during the last quarter of 1957, and building work a slightly smaller decrease. The increase in total expenditure between the first quarters of the two years was largely accounted for by an increase of about two-thirds in expenditure on vehicles. Expenditure on vehicles was at a low level in the first quarter of 1957, when the full effect of the Suez crisis was being felt. Estimates of the volume of fixed investment during the first quarter of this year, at 1954 prices, showed a small decrease when compared with the first quarter of 1957.

Expansion of Steel Production Capacity at Iscor

BY OUR SOUTH AFRICAN CORRESPONDENT

SINCE the post-war period has comprised, in South Africa, the recent phenomenally rapid growth of the gold mining and uranium industry, accompanied by an industrial development, the rate of expansion of which has most probably never been equalled at any period anywhere in world history, it is interesting to note that the kingpin of all such development, the steel industry, is forging ahead in the confidence and surety that it will yet play a still larger part in the development of Africa as a whole.

To obtain a clear picture of the rate of development which has occurred in the South African steel industry, it is necessary to recall that when the first ingots were cast in the works at Pretoria in 1934, the output was then scheduled to be 180,000 ingot tons per annum. In the following period up to 1939, this output was almost doubled. Notwithstanding this increased production, the local demand for steel well outstripped the supply, a state of affairs which became much aggravated during the war years. As a result, it was decided in 1947, besides carrying out extensions to the existing Pretoria works, to proceed with the erection of another fully integrated steel works at Vanderbijlpark. The two works together at the present time produce more than 1,500,000 ingot tons per annum, which is 66½ per cent of the Union's steel requirements. Now, ten years after the above decision was made, steps are being taken to increase the rated combined capacity by approximately 900,000 ingot tons per annum, bringing the total rated capacity up to 2,350,000 ingot tons per annum. By the end of this year it has been estimated that South Africa will be able to enter the export market for pig iron at the rate of well over 100,000 tons per annum after satisfying all local requirements under present conditions of demand. The works expansion, with this end in view, is now proceeding, and attention is being given to the question of finding a site for a third steel works, apart from the works at Pretoria and Vanderbijlpark, for some of Iscor's extensions at a future date. All relevant information is being gathered about promising sites throughout the country, so as to be ready when the time arrives to develop of a third site.

Most of the major plant for the extensions now under way has been ordered and some of it is already in the course of construction. As far as Vanderbijlpark is concerned, the coking capacity has already been increased by a second battery of coke ovens now in production. A third coke oven battery, together with necessary by-product plant and coal-handling facilities, is under construction. At Pretoria a new coke oven battery, with the necessary additions, is being installed, together with a second sinter plant of 2000 to 2500 tons a day capacity. Of particular interest is the new No. 4 blast-furnace now being built at Pretoria. This, when completed, will be the largest in Africa. Fig. 1 shows this furnace in process of taking shape.

The hearth diameter of the furnace will be 25ft and it is estimated that the production will be 10,000 short tons of iron per week. The height from ground level to the bleeder valve platform will be approximately 225ft. The furnace is also designed to operate, if so desired in the future, at high top pressure. The furnace plant will consist of the furnace, stoves, charging equipment, gas and air mains, raw material bins, coke weigh hoppers, coke screens, coke breeze conveyors and instruments. There will also be the downcomers, dust catcher with pug mill, scale and transfer cars and passenger-cum-goods lift.

The furnace charging equipment will be of modern design and will comprise a skip hoist, bell sequence, distributor, stockline recorders, controls for water additions and is so designed to work together as a complete unit with the coke screening, coke charging and breeze conveying equipment with interlocked sequence of automatic operation. Each unit, as far as essential interlocks allow, is designed so that it can be operated independently under "manual" control.

Three hot blast stoves will be provided and these are 25ft internal diameter and 110ft high. The working volume of the furnace will be 38,750 cubic feet, the number of tuyeres being eighteen. It may be of interest to record that the big bell weighs 22 tons. The weight of refractories will be of the order of 2750 tons, which does not include the stoves, the weight of the stove refractories being approximately 5600 tons.

The electrostatic gas cleaning plant is designed to handle 5,500,000 cubic feet of blast-furnace gas per hour (measured under standard conditions). The clean gas will contain a maximum of 0·004 grain of dust per cubic foot. This high degree of cleanliness is required as the blast-furnace gas is used as a fuel for the coke ovens. The plant will consist of two washing towers, two electrostatic precipitators, each precipitator having two cells, any of which may be shut down for routine maintenance. A water clarification and cooling plant is to be provided, together with all the necessary pumps. This plant is also fully instrumented.

To provide air for the furnace two steam-driven turbo blowers are being installed, one in operation and the other as a standby. The blowers will be of the double inlet type with automatic constant volume control to enable a selected volume of air to be blown with a minimum variation against any fluctuation in pressure within the specified range of the blower. Each blower will be provided with a complete anti-surging device and pumping limit governor. An air filter system will also be provided. Each blower will be capable of blowing 80,000 to 100,000 cubic feet per minute, measured under Pretoria conditions, with a delivery pressure of 18 lb to 22 lb per square inch gauge. Steam to the turbines of the blowers will be supplied from a new boiler plant. Three water-tube boilers, one as a standby, will be provided.

Of the major plant, the 65 to 70-ton electric furnace, shown in Fig. 2, is already in production. This is the first large arc furnace in the southern hemisphere, and was put into commission last year in the Pretoria works. It is an Efco arc furnace designed by the Electric Furnace Company, Ltd., of Weybridge, England, and is a top-charged, direct arc tilting furnace with three 18in diameter graphite electrodes connected to a 15,000 kVA transformer. The transformer is fed from a 33kV supply and is fitted with "on-load" tap changing. The furnace shell has an inside diameter of 18ft 6in, giving a nominal capacity of 70 short tons. Tilting of the furnace is operated hydraulically and the maximum angles of tilt are 40 deg. forward and 15 deg. backward. After making its first heat of steel in August, the furnace was immediately put on to a twenty-four hour per day production schedule. In the first full month of operation, September, 1957, 6800 short tons of steel were made. The average power consumption to date is under 500Wh per ton, and the electrode consumption under 8 lb per ton of steel melted.

Some details of the furnace design may be of interest. The furnace floor is flat and is supported on a robust chassis. This simple construction makes bricking of the lining easier, and will facilitate the fitting of a non-magnetic steel plate to the furnace floor, should an induction stirrer be required at a

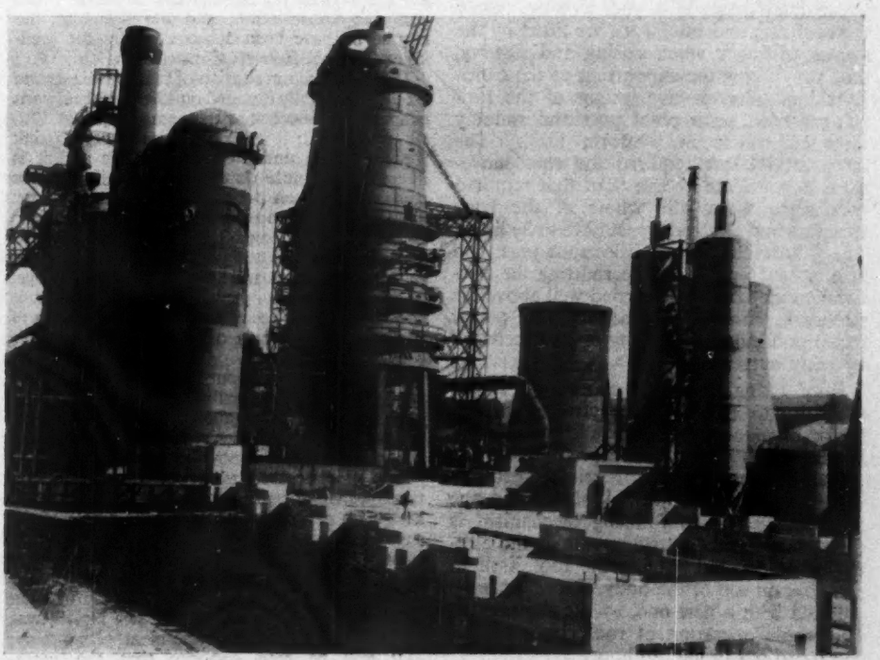


Fig. 1—No. 4 blast-furnace in process of construction

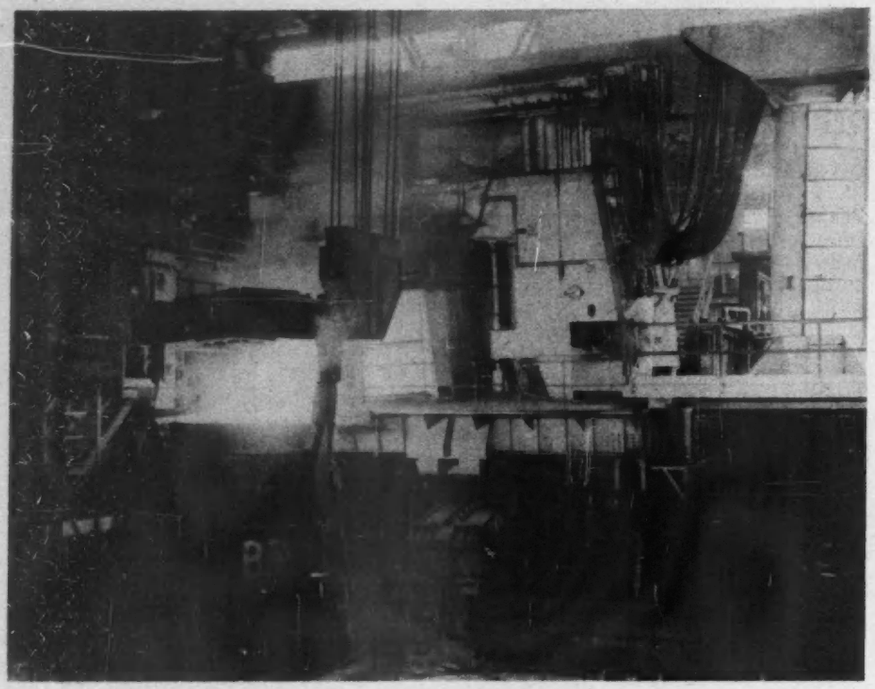


Fig. 2—The new 65/70-ton furnace in action

later date. The body itself, mounted on the chassis, is entirely independent thereof. It is made of skeleton construction, enabling the body plate, side panels and base panels to have " breathing " joints to cater for expansion, thus considerably reducing the risk of body distortion. These side panels are comparatively light, tack-welded plates, the use of which has been made possible by the sturdy main framework of the furnace, and can be removed for local lining repair from outside the furnace, and while it is still hot.

The back frame supporting the electrode raising gear and roof slew gear, is also supported on the chassis. However, the body and roof slew gear are entirely independent, thus avoiding the transference of torque or stress to the furnace body ; even with body distortion or roof ring distortion there can be no interference with roof slewing. Only the roof ring and brickwork are lifted by the system of levers when raising and slewing, thus simplifying the supporting of the cantilever load, the massive weight of the roof being carried on a pivot post and suitably mounted rollers at platform level. The mechanical effort required for roof movement is considerably less than that required in designs where the whole of the back structure and electrode mast have to be lifted. The gallows arm type of electrode mast and arm is used in this unit, permitting the electrical conductors to be carried well above the steelwork, improving the overall power factor and reducing heating of the steelwork by eddy currents.

Roof changing is very simple. It is not necessary to remove the electrodes—merely to grip them in the holders in a lower position. Neither is it necessary to remove the electrode cooler. The attachments are released between the lever system mentioned above and the roof ring. The roof-raising mechanism is then swung aside, carrying with it the electrode coolers, but leaving the roof itself in position, on top of the body, where it can be replaced with a new one, by the shop crane. The whole operation of roof changing can be carried out in half an hour.

The electrode masts are counterbalanced by a pneumatic arrangement incorporated within the masts. The total weight of each mast, together with the electrode assembly, is about 8 tons, and this is completely counterbalanced. By using air to counterbalance, the inertia of the moving parts is at a minimum. This system is so effective that only 3 h.p. motors are required for raising and lowering the electrodes. To enable maximum metallurgical control to be effected, the furnace is equipped with two doors, which are operated electrically.

The transformer, made by the English Electric Company, Ltd., is of the external water-cooled type, working in conjunction with an air-blast circuit breaker with a rupturing capacity of 750MVA. The transformer is provided with a range of tappings to give alternative furnace operating voltages, the required tapping being selected by " on-load " tap-change switchgear.

The ingot-making capacity of the plant will also be increased by the addition of an oxygen blowing plant, together with its own oxygen production plant.

The mills are being extended by the addition of a 144in plate mill, with full finishing facilities. The existing mills and finishing plant are being rearranged and modernised. With this in view, a new dolomite quarry has been commissioned at Mooiplaas, near Pretoria, while Vanderbijlpark will be supplied from a new dolomite quarry now being opened up at Glen Douglas, near Vereeniging.

The capacities of the iron ore mines at Thabazimbi and Sishen are being increased, and the degree of mechanisation stepped up. At Thabazimbi, a heavy-media ore beneficiation plant is being installed, whilst the Durban Navigation Colliery is being mechanised and the washing plant increased and modernised.

The total cost of all these plans, based on current prices and estimates, will be in the vicinity of £56,000,000. It is expected that the extensions will be completed by 1959–60.

Tugela River Bridge

ALTHOUGH not yet completed, construction having been begun early in October, 1956, some account of this structure, the erection of which has been delayed time and again by floods, should be of interest.

This bridge, being built over the Tugela River near its mouth, has several interesting features amongst which is that it was designed as the longest continuous concrete bridge ever to be built in South Africa. Also, the individual spans are the longest yet built in the Union in beam and slab construction, and the bridge is the largest to have been constructed by the well-known firm of Roberts Construction, Ltd.

The sub-structure consists of two abutments and six piers, generally founded on 40ft by 12ft caissons extending to bedrock at an average depth of 50ft. As anticipated, it has proved necessary to sink these caissons under compressed air and it is interesting to note that the final sealing of the caissons has been done using Prepakt concrete. This has proved to be a very satisfactory method of introducing concrete through an airlock. The caissons were designed for air pressure over the bottom portion and have no steel cutting edge, so that when an uneven founding surface is encountered it is easier to trim off the bottom of the concrete to form a good seal against the rock.

The piers are about 50ft high, relatively slender, with semi-circular ends. Sliding forms have been used throughout in the construction of these piers, and after some initial difficulties, a very good finish is now being obtained.

The superstructure is supported on pendulum type meehanite bearings, approximately 4ft high, except on pier No. 3, to which the whole of the superstructure is fixed horizontally on a hinged joint. All longitudinal horizontal loading on the bridge is therefore taken on this pier. The superstructure is being constructed span by span and, until it was connected to pier No. 3, was tied back on to the south abutment.

It will be seen opposite that the superstructure consists of a deck slab connecting two main beams. Each main beam is stressed by means of twenty-eight cables, each consisting of twenty-four 7mm high-tensile wires. Stressing of the deck is done from one side of the bridge only by means of looped cables of 14mm–7mm wire construction at 4ft centres. The total weight of high-tensile wire is approximately 200 tons. The overall depth of the superstructure is 7ft 6in at midspan, parabolically haunched to 11ft 3in at the supports. Three spans are now complete.

During the whole of the construction period, the engineers and men on the job have been harried by floods, seasonal and unseasonal. Sinking of caisson No. 5 had been commenced during the last dry season, but was delayed when the river rose after the melting of the heavy snowfalls experienced last winter on the Berg. The early rains which followed culminated in a flood in the early part of September last year, which was, in fact, higher than anything recorded during the whole of the previous rainy season. At this stage No. 5 caisson was on its way down and had been constructed to a height of 32ft, but this was insufficient to prevent undermining due to scour and the resultant overturning of this caisson. At this stage there can be no better way of giving some inkling of the phenomenal flood troubles experienced than can be gleaned from the following extracts from a diarised newsletter issued by the firm.

" During the period 13th May 1957, to the end of June the river levels had fluctuated between 18·50 and 19·50, but suddenly on Thursday, July 4th, the river level rose to 21·50 and by the following day had reached its peak level of 27·5 . . . . .

" *Caisson No.* 5.—By the use of a bulldozer a peninsula of sand was pushed 120 feet into the river and protected on the upstream side and the exposed end by steel sheet piles and numerous hessian bags filled with sand. The depth of the water at the exposed end was approximately 9 feet and difficulty was experienced in counteracting the scouring effect of the rapid flow. The shuttering for the cutting edge was set up, the concrete poured in and sinking was com-

menced in rapid time. The 2nd Lift was cast only just in time, as the concrete was still wet in the shutters when the river rose rapidly, swollen by general rains and melting snow in the interior. The river rose 2ft on the day the concrete was placed covering the first 12ft of shuttering, and the following morning the river had risen to such an extent that only the top corner of the caisson was visible.

"The width of the river expanded from its normal winter flow value of 300ft to its full mid-summer width of 500ft. Severe scouring behind the sheet piles and around the caisson caused the sheet piles to disappear altogether, and the caisson to settle about 5ft out of level, dipping towards the upstream side. In the course of the next two days the water dropped about 18in and the caisson settled on the downstream side giving a present tilt of approximately 3ft over the length. Fortunately the concrete is completely unharmed, but the retrieving of the shutters which are still in position is going to be an extremely wet operation ! ! . . . . .

"The stripping of these steel shutters proved an extremely difficult operation, in view of the fact that a considerable part of the caisson was under water, and it was necessary to bring the aqualung into service. Once the stripping had been completed, the problem of levelling the caisson was tackled, using the mobile Scotch crane and grab, working from the temporary trestle bridge. Excavating cautiously from the upstream side of the caisson only, we eventually succeeded in re-levelling the caisson to find that it had been displaced horizontally 9in in an upstream direction—which is really very little considering the extreme angle of tilt at the height of the flood. We were indeed fortunate as it could have been very much worse."

There was, unfortunately, "much worse" to come, as appears from the November newsletter.

"*The Flood.*—We have carried on a running battle with the river, which so far seems to have won every round. The first blow was struck on Friday, 13th September, when at 8 a.m., a telephone message was received from Tugela Ferry that the river had risen by about 10 feet. At this stage work was in progress connecting the downstream beam of Span No. 2, and, apart from the final cleaning out in caisson No. 3, all work was concentrated in the river where the water level had remained fairly constant at about 20. The first 8ft Lift of the upstream leg of No. 6 caisson had been cast three days previously, and stripping of the shutters was in progress.

"On receipt of the news, our immediate reaction was to clear the river bed of all movable equipment, piles, sheet piles, etc., and to attempt to sink caisson No. 6 as far as possible, in order to avoid losses similar to those sustained after the previous flood. All available labour, except those actively engaged in concreting or in the airlock, was employed in removing sheet piles from the various islands and timber piles from the bank nearby, and dismantling and removing the track which had been laid for recovering sand from the river by coco-pan. Our chief concern was for No. 6 caisson which was entirely exposed above the sand and offered an extremely vulnerable target for any kind of flood. We succeeded in stripping the cell shuttering by 12 o'clock, but had difficulty in removing the cutting edge forms, as the water was rising slowly in the cell. In the meantime the river had risen 12 inches and remained at that level for the rest of the day. The caisson was finally sunk 4 feet into the sand by means of a water jet. The shutters were then taken up to the trestle bridge and stacked, and the scaffold boards removed from the light gum pole bridge extension to the main trestle bridge.

"This work was completed by 5.30 p.m. and the river level was still at about 21, although the rate of flow had increased. We considered that a rise in water level of 11 feet at Tugela Ferry would probably amount to no more than about 5 or 6 feet at the bridge, where the river valley is considerably wider and the trestle bridge had already stood up quite satisfactorily to a flood, during which the water level reached 28. The top of the bridge is at 30, and the river had previously attained this level in January last, rising from a mean summer level of 27. The highest recorded flood level last summer was 32·75, after very heavy rains, and as there had been no reports of heavy rains inland during the past few days, we felt that there was no risk of losing our bridge.

"Between 6 p.m. and 9 p.m. the river rose to Level 26, as we had anticipated and remained at this level until 11 p.m. when the watchboy reported that the river was again rising. By the time that the native boys had been rounded up from the compound it was 11.30 and the centre of the river was at that stage 3 feet above the bridge level of 33, there was no sign of the crane and it was impossible to get on to the bridge to recover any other items of plant.

"On the following day, the water was still flowing over the bridge, and all that could be seen of the Scotch crane was 15ft of the jib, standing vertically in midstream. All the rest of our plant which had been fixed to the bridge had disappeared completely. As the water gradually subsided during the next few days, it was seen that a large section of the bridge, about 200 feet in length, had been completely removed and carried out to sea . . . . .

"By the 18th September the water level had dropped to 25 and enabled us to reach caisson No. 5, which at this stage was just appearing above the water. The upstream end of the caisson had moved 12 feet 6 inches in a northerly direction, the downstream end had moved 4 feet 6 inches in the same direction and it was 3 feet out of level across the short axis. This had obviously been caused by excessive scour on the north side of the caisson, which must have been of the order of 25ft in depth. (The caisson was 32ft in length.) The Scotch crane had been carried bodily off the bridge and had settled over the group of 45ft timber piles which had just been driven to support the steel staging base north of No. 5 caisson. The crane was already covered by about 10 feet of sand and only the jib remained visible . . . . . .

"By the 27th September, the water level had dropped to 27 and a start was made on dewatering and cleaning out No. 3 caisson. Work was progressing nicely when a further flood warning was received from Tugela Ferry and the pumps were hastily removed. This time the river reached Level 35·2 in a matter of two hours.

"The river level had dropped to 28 on 30th September, and another attempt was made at dewatering the large dam in which No. 3 caisson was situated. By the 2nd October, most of the mud had been cleaned out of the caisson, and preparations made for concreting, when another flood warning was received from Tugela Ferry. Everything was hauled up on to high ground and by 5 p.m. the river had reached Level 31. The level remained fairly constant overnight, but started rising again at 10 a.m. on 3rd October. By 4 p.m. it had reached Level 39·2 and we were in danger of having the excavation for No. 2 caisson flooded. At this stage the river had almost doubled its width, being about 800 feet wide at the bridge, and we were wondering where it would stop. The flood waters had reached their peak, however, and gradually receded overnight.

"By 5th October the water level was down to 28·5, leaving No. 3 caisson covered with mud and matted grass. We were not surprised to find that the remainder of the trestle bridge north of No. 5 caisson, and a section between Nos. 4 and 5 caissons, had been carried out to sea. The Scotch crane jib had also given up the unequal struggle, and disappeared from view, as had both No. 5 and 6 caissons. We are as yet unable to find out exactly what has become of these two caissons, as the river has not yet dropped to a sufficiently low level. The water level has since fluctuated between 25 and 28 generally but rose to 30·5 on the 30th October. No further damage has been caused, however, but our programme of construction has been most seriously affected."

Since these words were written the present position of the caisson No. 5 has been determined by probing through the 20ft of silt which now overlies it and it has been discovered that it fouls the position of a replacement caisson by approximately 14ft. Owing to the fact that work can be carried out in the river itself over only a strictly limited period, and as it is desired to complete the bridge by the end of the year, any attempt to remove the obstruction seems to be out of the question. At present it seems that the original programme can only be adhered to if the bridge is redesigned so as to alter this pier position. Even if this is done it may be necessary to provide falsework for three spans instead of for one only as at present.

To a certain extent, such a redesign will spoil the final result, and, for this reason, many suggestions for removing the overturned caissons have been investigated. While it is, no doubt, possible to move the obstruction, no method likely to achieve this in the time allotted seems to be available.

The construction of this prestressed concrete bridge across the Tugela near its mouth has been substantially delayed by unusually frequent and prolonged flooding of the river

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"WHITE LINES."—The first issue of a new house magazine "White Lines," has been received from Thomas White and Sons, Ltd., Laighpark, Paisley, Scotland, the wood-working machinery manufacturers. It is intended to publish the magazine quarterly, and it will contain particulars of new machines as they are developed as well as details of the firm's activities and technical information of interest to woodworking companies.

Water Power on the Vltava River

By JAROSLVA MARTINEC

CZECHOSLOVAKIA is situated "on the roof" of the European river system in the catchment area of the North Sea, the Baltic and the Black Sea. With the exception of the Danube all rivers originate in the mountain areas of Bohemia, Moravia and Slovakia. Consequently, their length does not exceed several hundred miles. The average discharge on the River Elbe at the Czechoslovak frontier is 11,000 cfs.

As there is no abundance of water sources in Czechoslovakia, and in view of the rapid development of industry, agriculture, and of the growing demands of the population, it was necessary to ensure the planned distribution of water with regard to hydrological conditions and the interests of the economy.

The State plan for water management which has been drawn up contains general provisions for agriculture, forest management, water supply, sewage, water pollution control, harnessing of water power and construction of big dams.

It is especially water power development which has gained a great significance in recent years. The production of water power in Czechoslovakia increased as follows :—

Year	Production, million kWh
1918	85
1930	270
1938	580
1948	850
1950	900

The present share of water energy in the total production of electric energy is about 10 to 12 per cent.

Practically harnessable water power resources, according to estimate, amount to 10 milliard kWh per annum and are at present exploited to the extent of 20 to 25 per cent.

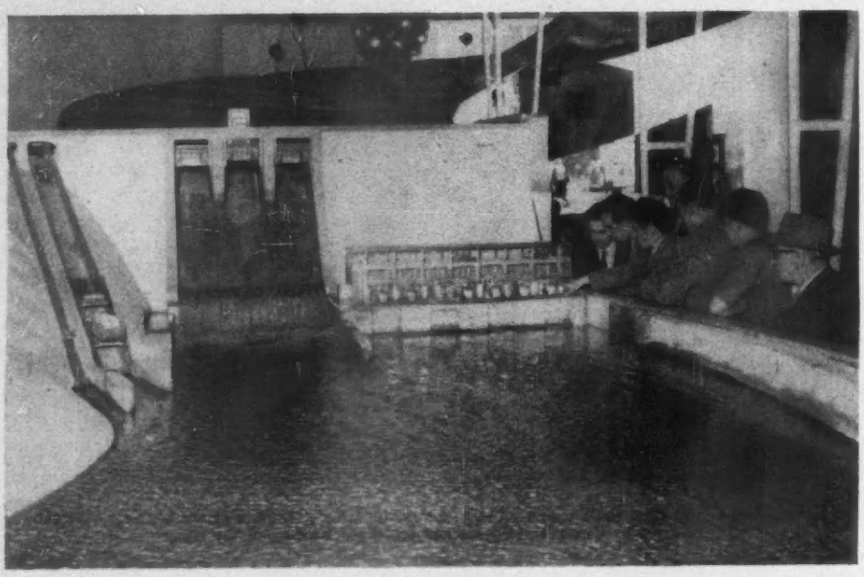
The two major hydro-energetic systems in Czechoslovakia are the Vltava (Moldau) development and the Váh (Waag) development.

The Vltava Scheme.—It is particularly the reservoir system on the Vltava River, "the Vltava cascade," as it is often called, whose operation involves a variety of technical problems and tasks to be fulfilled in the interests of the national economy. Harnessing the water power, flood control, water pollution control, potable water supply, navigation, changes in water temperature with regard to irrigation and recreation possibilities—all these aspects must be properly balanced by the unified operation of the whole multiple-purpose reservoir system.

The watershed of the Vltava River is comparatively sparsely populated and offers an excellent opportunity for creating large reservoirs and concentrating the river slope into high heads for electric energy generation.

There will be four major reservoirs (Lipno, Krumlov, Orlík and Slapy), four smaller ones and four compensating reservoirs. The three biggest dams and power stations have the following characteristics :—

	Construction started	Completed	Installed capacity, MW	Average annual production, million kWh
Lipno ...	1951	1958	120	150
Orlík ...	1955	1961	360	400
Slapy ...	1949	1956	144	325



Model of the Orlík dam and power station at the Brussels exhibition. The station will have four 94MW Kaplan sets, each for a head of 231ft and a discharge of 5300 cubic feet per second. On the left are the two sloping ship lifts for 300-ton and 3-ton vessels respectively

Including the remaining plants, the total installed capacity of the whole system will be more than 800MW and the annual production of electricity more than 1,125,000kWh, much more than the total production of water power in 1950.

With the construction of the dams in progress the Hydraulic Research Institute in Prague is carrying out tests on small-scale models as well as studies of reservoir operation with regard to the multiple-purpose use of water and flood control.

Navigation.—In the final project of the Vltava development the energetic point of view overshadowed all other aspects, thus making the conditions for river traffic in the middle course of the river rather difficult. As there is a great need of river transport in this area, at least river traffic of 300-ton vessels is planned. Shiplifts on the highest dams—Slapy and Orlík—and navigation locks on other dams are to be built for this purpose.

Flood Control.—The problem of flood control is very important in view of the capital, Prague, being situated below the reservoir system on the Vltava. With the large reservoirs filled to capacity the travelling time of a flood will be speeded up. Therefore correct manipulation of the segment gates, which are situated on the crests of the dams, is necessary to protect Prague from floods.

Recreation.—The effects of reservoirs on recreation possibilities will be both favourable and unfavourable. In river reaches below the dams unpleasant cooling of water may be often felt in the summer months. On the other hand, the large water surfaces created by big dams offer an excellent opportunity for water sports and yachting. Thus, the Slapy dam above Prague has become a favourite recreation centre.

The Vltava Cascade at the Brussels World Exhibition.—At the Brussels World Exhibition the Czechoslovak Water Management is showing a display of the Vltava cascade. A blue ribbon representing the Vltava River passes above the heads of visitors, with the whole series of dams which are projected, under construction or already completed.

The biggest dam of this system, the Orlík, is represented as a model to a scale of 1 : 70, built in a manner to give, as far as possible, an impression of reality. Flood waters are overflowing under the open segment gates from the crest of the dam into the stilling basin and water is also flowing through the penstocks of the power-house. Through the transparent walls one can see all details, including the four generating sets.

There are two especially interesting details at the Orlík dam, the first being the use of Kaplan turbines for the very high head of 231ft. As is well known, the development of the Kaplan turbine is connected with Czechoslovakia from the very beginning. The turbine is named after Viktor Kaplan, professor at the Technical University in Brno (Moravia), who improved the efficiency of the propeller turbine by means of adjustable blades. Kaplan turbines were soon built all over the world and were considered suitable for lower heads up to 100ft. In exceptional cases Kaplan turbines for higher heads have also been constructed, for example in Sweden for a 170ft head and in Scotland for a 162ft head. However, these cases were surpassed by the Kaplan turbines for the Orlík hydro-electric plant, when each of the units is designed for a discharge of 5300 cfs and a maximum head of 231ft ; a new kind of runner with ten blades has been developed for this application. As compared with the Francis turbine, which would be normally chosen under the given circumstances, the use of the Kaplan turbine has the advantage of having a greater speed, thereby offering substantial savings in generator dimensions and costs. In addition, within the given variation of head between 231ft and 154ft, a higher guaranteed output is achieved with practically the same efficiency.

Another original design on the Orlík dam is the sloping ship-lift, which will carry ships up to 300 tons and have a parallel ship-lift for sporting vessels up to 3 tons. The ship-lift overcomes a difference in water level of 231ft. The ships are transported in a steel reservoir filled with water, which enters the upper and lower reservoir in a manner enabling the ships to float directly into the water. The reservoir level fluctuates up to 23ft during the navigating season, and a special arrangement enables the ship-lift to cope with this fluctuation. The lift is driven by an electric tractor on rack rails. When moving down slope the tractor is checked by regeneration, the motors functioning as generators. Thus greater safety of transport and cuts in costs are achieved, because an important part of the consumed electric power is returned into the grid, which is working in fact as a counterbalance weight of the lift. One ship will be transported in less than twenty minutes and the electric power needed will be less than a tenth of the energy of the water which would be necessary for the operation of navigation locks at such a great difference of water levels.

This solution, which has not been used so far under similiar conditions elsewhere in the world, is very advantageous both as regards the invested capital and the operational costs, in comparison with a number of alternative solutions such as vertical lifts or locks. A working model of the ship-lift also forms part of the model of the Orlík dam in Brussels.

Breguet "940" Blown-Wing Aircraft

THE experimental blown-wing Breguet "940" aircraft carried out its maiden flight on May 21. The aircraft, which is shown in our first illustration, weighs 7 tons and has a span of 58·8ft and a length of 49·5ft. It is powered by four 400 h.p. Turbomeca "Turmo II" gas turbines driving four Breguet propellers constructed by Ratier-Figeac. These have a diameter of 12·4ft and are connected with one another and thus synchronised by an automobile type transmission shaft with universal joints.

The metal fuselage has a cockpit for one pilot and one mechanic, and with good forward view. It is also equipped with a hold and a retractable loading ramp. The wing is placed at the top of the fuselage and the double-fin tail unit is also placed in a high position, outside the slipstream from the propellers. The stabiliser has an adjustable angle of incidence and is fitted with double elevators. All controls are actuated by servo mechanisms.

The tricycle landing gear is fixed and the main wheels equipped with brakes and low-pressure tyres.

The double high-lift flaps (Fig. 2) are hydraulically controlled. A sandwich arrangement of bonded aluminium alloy honeycomb has been used for the wing skin and the floors.

Due to the free turbines of the "Turmo IIs" and the connecting transmission, the lift symmetry at low speeds is assured even if one engine should fail. A speed range of cruising speed : take-off speed of 4 : 1 is aimed at. Design maximum cruising speed is 188 knots, and the machine is stated to be able to take off in under 360ft and land in less than 328ft.

For some years past the Breguet Company has devoted its attention to problems related to lift and short take-off aircraft.

The company, which before the war was one of the foremost helicopter producing firms—one recalls the Breguet No. 1 in 1907 and the world's gyroplane records in 1934—gradually came to the conclusion that for a transport craft using a short take-off run, it would be preferable to base their studies on the conventional fixed-wing type plane, which is cheaper, more versatile, and far more economical. Much work was still to be done on the fixed wing, however, if take-offs were to be achieved which could hope to rival the near-vertical take-off of the helicopter, and over-dimensioning the high lift flaps would lead to prohibitive weights and drag factors. Thus was born the idea of the "blown-wing principle," combining the advantages of a high-lift aircraft (such as the "Prestwick Pioneer" and "Do.27"), with those of convertible propeller aircraft, while at the same time eliminating the disadvantages (such as nosed-up flight attitude, delicate transitions, complex mechanical parts, and lack of safety in the case of the power unit failing). The rectangular shaped wing is completely swept by the airstream from the four large propellers which are driven by free gas turbines, which turn in pairs, in opposite directions, to ensure symmetry. The propellers are greatly geared down (to about 1000 r.p.m.) and, as has been mentioned, are mechanically synchronised by a shaft located in the leading edge.

The slipstream from the propellers is deflected downwards by the powerful double trailing flaps, which are extended to almost 90 deg. During the take-off, this airstream produces a strong aerodynamic reaction on the wing, which, combined with the traction power of the propellers, tilts the aircraft forwards and it unsticks after an extremely short take-off run. It climbs at a very steep angle, the flaps are gradually retracted and the forward flight speed increases, since the aerodynamic lift-to-drag ratio of the aircraft is close to that of a conventional aircraft. In horizontal flight, the propeller slipstream increases the lift produced by the forward speed. During landing the same process takes place in the reverse order.

By raising the nose for the take-off, it would be theoretically possible to make a vertical take-off, and the aircraft would behave like an inclined rotor helicopter whose wash is deflected downwards. When the resultant of the lift is greater than the weight, the craft rises. This theory, however, presupposes that the problems of stability and piloting at a horizontal speed of zero have been solved (non-stability of the slipstream, unfavourable influence of the ground effect, dive moment of the flaps, &c.).

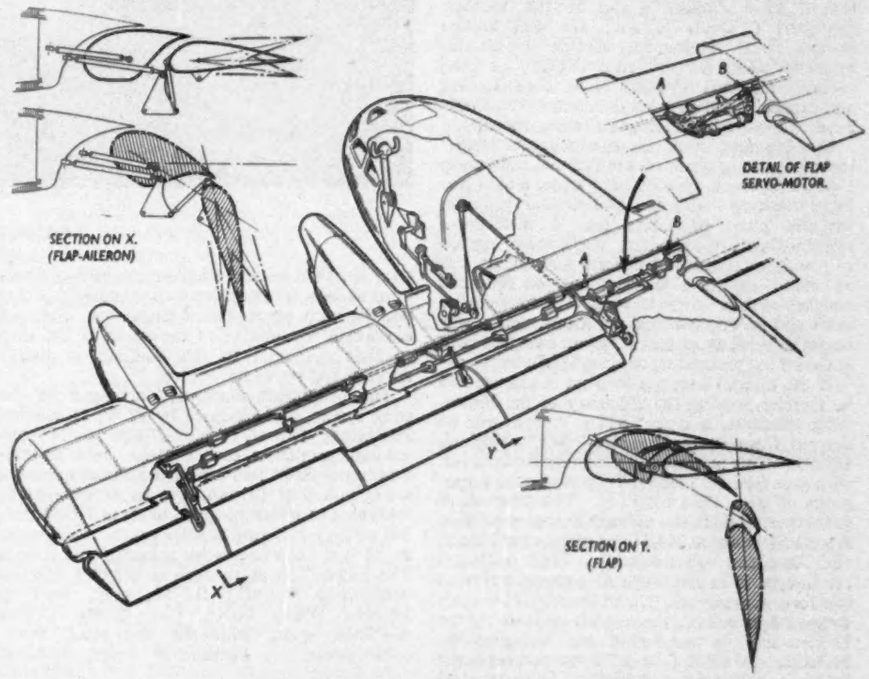


Fig. 2—Double aileron and flaps mechanism of the Breguet "940."

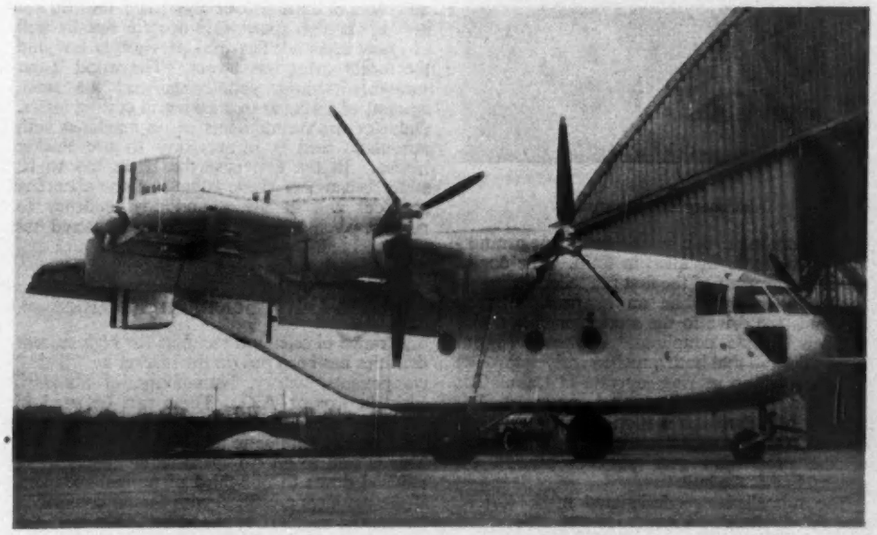


Fig. 1—The Breguet "940" blown-wing aircraft is an experimental short take-off plane of 49·5ft length and 58·8ft span. The 7-ton aircraft is powered by four synchronised propellers driven by four 400 h.p. "Turmo II" gas turbines

In its desire to advance gradually the company does not for the present intend to carry out hovering flights, since short run take-off at low speed already implies a great efficiency of the lateral control surfaces and of the tail unit. In this respect, it should be noted that inasmuch as the flaps cover the entire wing span, and the aileron action is provided by the differential deflection of the tip flaps, it is planned to vary the pitch of the outboard propellers differentially and automatically, so as to counteract the inverse yaw movement and improve lateral control.

Long before the war, the Breguet Company was greatly interested in questions pertaining to lift. The "Br.730" aircraft and the interceptor "Br.690" were even then equipped with airfoils and slotted wing flaps that were especially designed for giving the aircraft excellent lift characteristics. These flaps and the application of the slot, which was a passage through which the air is made to flow by the pressure differences between under and upper wing surfaces, were extensively studied at the St. Cyr Technical Institute, using the modified wing of the "Br.19."

The bomber craft "Br.482," which, as a result of the occupation, could not be entirely finished, was completed after hostilities had ceased, and from the lift point of view represented a considerable advance.

A commercial derivative of this bomber, the "Br.500" aircraft, had a cruising speed of 216

knots and a minimum speed of just over 70·1 knots. It was equipped with double slot flaps and a flap retraction device.

The aircraft carrier interceptor plane "Br.960," and the anti-submarine aircraft "Br.1050," which is derived from it, are also provided with highly developed lift systems.

The tactical support plane "Br.1001" "Taon" may be considered at present as holding the maximum C_L record suitable for utilisation, for an aircraft having a pronounced sweepback (42 deg.) and a very thin symmetrical profile.

For some time now, several foreign companies have also been keenly interested in the important question of lift. The products of Scottish Aviation ("Twin Pioneer") and of the Dornier Company ("Do.27"), &c., are well known in this field. Numerous designs for aircraft requiring short take-off runs (STOL) or even vertical take-offs (VTOL) have been studied and experimented on in other countries (by Lockheed, Convair, Ryan and, in France, Snecma).

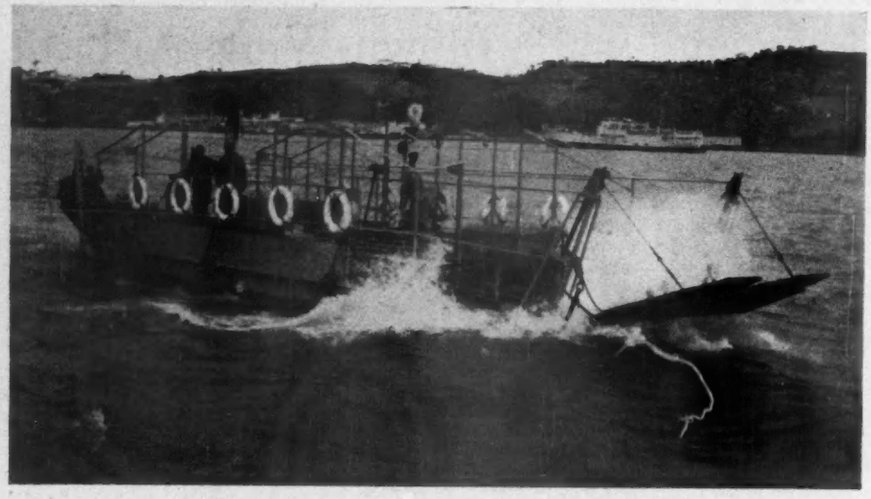
Development work on the Breguet "940" included a long series of wind tunnel tests using a powered mock-up to 1 : 7·5 scale, and a free flight mock-up scaled at 1 : 6 and equipped with variable pitch propellers and a mechanical transmission system which is an exact replica of the characteristics of the real aircraft, as well as endurance tests carried out on full-scale benches with a complete wing with four engine units and an interconnection. Construction was begun in 1957, as soon as sufficient data had been gathered for proceeding to actual flight tests.

If the aircraft lives up to what is expected of it, thereby proving the efficiency of the blown-wing principle, a true "STOL" craft will be derived from it, the Breguet "941," weighing 18 tons. This aircraft will probably be equipped with four General Electric T–58 American turboprops of more than 1050 h.p. The prospect of such an aircraft in the military transport version is stated to interest NATO as well as the French and American Governments. Civil operators are interested in the cargo or passenger version (for forty passengers). Under the recent Piasecki-Breguet agreements, the aircraft ordered by the U.S.A. will be assembled and delivered by Piasecki. A 656ft take-off from non-prepared fields is envisaged. Boundary layer control devices will probably be used, for sucking and blowing on the high lift flaps and the tail unit. It is stated that Breguet was the first company in France to fly an aircraft equipped with a device of this sort, the prototype of the aircraft carrier fighter "963 Vultur," equipped with an Armstrong Siddeley "Mamba" turboprop, and a Rolls-Royce "Nene" jet. Part of the jet air is tapped at the compressor, and distributed in the wing, to a series of injectors located along the leading edge of the flap, where the jet induces a secondary current, producing a strong suction in the slot and blowing on the leading edge of the flap. Considerable gains in lift are claimed to have already been realised.

Cone Propeller Ferries

Now being shipped out to Portuguese India are two steel double-ended ferries which have been designed and built by the Companhia Uniao Fabril, Ltd., of Lisbon, to the order of the Portuguese Colonial Authority. One of the ferries is seen on trial in our illustration and each has the following dimensions: length overall 68ft; waterline length 55ft 10in; breadth 18ft 7in; depth at sides 5ft 9in; depth of hull at carriageway 3ft 6in; and width of carriageway 11ft 6in. On a draught of 1ft 9in the ferry can take a load of 20 tons, consisting of two 10-ton lorries, or cars with passengers. The side decks which are 3ft 6in wide provide space for passengers and a control station, while at each end of the ferry are adjustable landing ramps. No rudders are fitted and the vessel is both propelled and steered by sets of Hotchkiss internal cone propellers which are arranged in the wing spaces under the side decks.

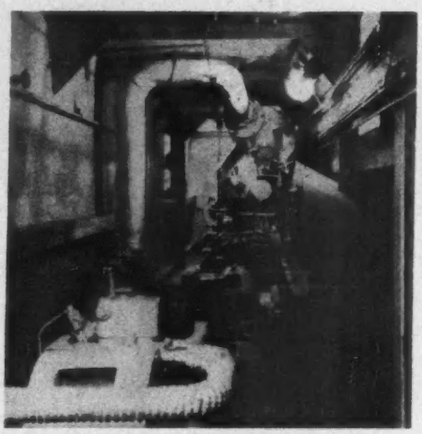
This propulsion system allows the ferry to be propelled at equal speed in either direction and also makes a steering wheel unnecessary since control, of course, can be effected by manipulation of the engine telegraphs. These directly control the engines, through hydraulic servo gear, and if one



Ferry on trial at Lisbon

lever is pulled back the ferry turns in that direction, while with one lever forward and the other aft, the craft pivots about amidships. Steering is effected irrespective of the speed of the ship so that approach to the landings is always accurate and under full control.

The propulsion machinery arranged in the wing spaces, and designed by D. V. Hotchkiss, Parkestone, Dorset, consists of two sets of internal cone propellers, each set driven by a Thornycroft mark RNR four-stroke diesel engine having six cylinders of 121mm bore by 165mm stroke and rated at 90 b.h.p. (maximum) at 1600 r.p.m. but arranged to run at 1500 r.p.m. and derated to 72 h.p. Cooling is by a fresh water circuit. The engine drives through a directly coupled continuous reversing S.L.M. gear, built by Modern Wheel Drive, Ltd. Owing to the restricted space available, the equal thrust cone propellers, instead of being mounted



Machinery in wing spaces

in the more usual side by side twin cone arrangement, have been installed in train. The engine drives the layshaft of the first propeller through a flexible coupling, while an intermediate shaft transmits the drive to the second propeller, also through flexible couplings, as shown in our illustration, so that both impellers, driven through worm reduction gearing, operate in train. The propeller system is mounted upon shallow tunnels of rectangular section, one on each side of the ship and about 4½in deep, so that no part of the propulsion gear projects outside the general line of the hull.

The propellers are designated mark 48/I.W. and the discharge stream from one cone passes under the discharge stream of the following cone. Each unit consists of the frustum of a cone forming a whirl chamber, of which one side is cut away and open to the sea. At the large end is an impeller which when rotated causes water in the cone to spin about the impeller axis and be discharged tangentially. A point is reached where centrifugal force changes to centripetal force, causing an inflow of water which increases in intensity towards the small end of the cone. Radial impeller blades ensure that the thrust is equal in either direction. This thrust acts upon the internal surfaces of the cone and the impeller sustains torque only, so that there is no thrust bearing. The mean speed attained by the ferries on trial was 6·45 knots, the contract speed being 6 knots.

Four-Sided Saw Disc

Savings in power, cutting losses and cutting time, and reduced wear of the saw are claimed for a new design of blade for use on circular saws, introduced by Sieper and Co., Remscheid, German Federal Republic. This saw blade possesses four groups of teeth, the intervening gaps taking the form of straight lines consecutively at right angles, so that the blade is a square sheet of metal with rounded corners on which the saw teeth are formed. The first tooth of each group is less high than the rest and receives no set. The set of the remaining teeth need not be greater than 10 per cent of the thickness on either side. Diameters range from 160mm to 1200mm and thicknesses from 1·0mm to 5·3mm. A 600mm diameter blade has a thickness of 2·8mm.

It is stated that the same blades are suitable for all grades of hard, soft or plywood; they do not heat up at high speed, and operate equally well at lower speeds. The feed pressure is low and the motor takes less power. The wood is cut smoothly without splintering, and the small amount of set leads to a saving in cutting losses. Only for use on moulders or on machines with automatic feed is it necessary to use thicker blades. In the first case the blade has to be stiffer because of the smallness of the clamping shoulder and in the second any tendency to run-out when a harder patch is encountered has to be resisted.

High-Duty Selenium Rectifier

A range of selenium rectifiers for high current densities has been put on the market by "SAF" components factory, Nuremburg, of Standard Elektrik Lorenz A.G. These can be used in bridge circuits with currents of 130mA to 250mA per square centimetre of effective plate area. This is said to enable space requirements to be reduced down to one-third of normal rectifiers. If the rectifiers are fitted with forced convection cooling or installed in an oil tank, the load can again be trebled, with further savings of space The new development, it is stated, was made possible by the introduction of large-area vacuum splutter coating.

The American Scene

BY OUR AMERICAN EDITOR

Current Outlook for American Shipyards

Shipbuilding in the United States, which hit its stride late in 1956 and early in 1957 with full order books, has a full schedule ahead of it for 1958 and partly for 1959. Before the wave of cancellations struck the industry late in 1957 and early in 1958, it was scheduled solidly into 1960. This year started off well with the ordering of fifteen dry-cargo ships by subsidised operators. Following these orders, there has been only one order for a sea-going ship and that was a 6000-ton dredge for the Corps of Engineers. The third quarter of this year does not appear to offer much hope of orders for large ships. With strong efforts on the part of industry and the Government, the fourth quarter should wind up the year with strength. If present schedules can be met, orders for seventeen freighters and one or two passenger ships should be placed. Bids already have been requested for four of these, and the other bid solicitations are to be sent out during the next few months. Orders for inland-waterway vessels have shown a decline in recent months. This is a natural result of the nation-wide business recession.

The Shipbuilders' Council of America reported that at the close of 1957, private shipyards had unfinished business under way totalling approximately 1,826 million dollars. This figure far exceeds all previously recorded years except the war period of 1941 to 1945. Of this total, 874 million dollars represented commercial work and 952 million dollars was in Navy contracts. The Council reported further that employment in private and naval shipyards rose during 1957 from 221,100 in January to 229,500 in August. Between then and the end of the year it tapered off to 222,300 workers. The 100 construction and repair yards reporting to the Council had an average of 43,536 employees on new construction and 37,627 on repair work during the last quarter of 1957. This was the highest quarterly total since the last quarter of 1953. Navy yards employed 93,600 workers, or 42·1 per cent of the estimated 222,300 workers employed at the beginning of 1958.

The total volume of ship-repair work during 1957 totalled 435,470,000 dollars—a new peacetime record. However, the picture for future work in the repair yards is not so bright. The Council report took note of this condition, stating that the number of U.S. flag vessels have decreased about 10 per cent during the past year. This percentage may become greater if the market conditions do not change rapidly.

Tanker orders still dominate the market for ship construction even after allowing for the present cancellations. As of May 1, the shipbuilding summary published by *Marine Engineering* showed sixty-eight tankers on order out of a total of 103 ships. The balance was made up of twenty dry-cargo ships, seven bulk carriers, five passenger ships, three ferries, one dredge and one survey ship. The start of a steady flow of ship-replacement orders has now begun. While the first replacement ships were the Moore-McCormack and Grace Lines' passenger ships ordered two years ago, this year saw the actual beginning on the steady programme. Four steamship companies—Lykes Brothers, Moore-McCormack, American Export and American President—placed orders for fifteen dry-cargo ships. If Congress approves the Maritime Administration's plans, eighteen more ships will be ordered this year. These would include ships for American Mail, Lykes Brothers, Mississippi Shipping, Moore-McCormack and Pacific Far East, together with a passenger ship for the American President Lines. The Maritime Administration appears to be confident that its programme will receive Congressional approval. With yearly approvals, the subsidised operators will be required to replace 304 ships by the middle of the 1970s. At the present time eight lines have signed operating contracts committing themselves to build 195 ships at a total cost of 2020 million dollars. The replacement plans of the other subsidised operators have not been announced. However, it is certain that their plans will be determined when their subsidies are renewed.

One other ship-replacement is pending that has the concerted interest of the entire shipping and shipbuilding industry. This one is the ship to replace the S.S. " America." The plans announced by the United States Lines calls for a vessel similar to the S.S. " United States." Bids were received a year ago for this ship, but Congress eliminated the funds for it last year. This year the Maritime Administration did not request an appropriation since separate legislation was pending in Congress. The closing days of this session of Congress should determine whether this special bill will be passed or the replacement schedule returned to the Maritime Administration to be handled in the same manner as all others.

In general, the American shipyards are in a healthy position at the present time but face problems that are common to all businesses. The annual report of the Newport News Shipbuilding and Dry Dock Company stresses one of these problems. The report states : " Extensive replacements of the Company's properties, and those owned by the Navy, are expected over the next few years. In the Company's particular situation, the costs of replacements in most cases are many times the original costs, even after eliminating any 'betterments' involved in the replacements. . . . The expenditure of these funds does not appreciably increase the company's productive capacity or efficiency." This situation is true in all yards. The lean years following the war made it impossible to modernise or even to maintain all the facilities. Now that a healthy condition exists, facilities must be improved or brought back to good working levels. Legal depreciation limits do not allow for the increased costs. Yards have expanded to meet the present-day work load and to remain competitive. Bethlehem Steel dismantled six standard shipways at Quincy to accommodate a building basin which has three building positions, or graving areas, for the construction of from three to six ships, depending upon their size. Sun Shipbuilding and Dry Dock has done a major rebuilding job. Several old ways were removed to provide for ways capable of handling larger ships. In this manner many U.S. shipyards have shown their good judgment and willingness to spend large sums of money to improve production facilities.

The future is considered to be good for U.S. shipbuilding. The shipowners have shown their good intentions of replacing their ships. The shipbuilder is showing his faith in the future by rebuilding and improving the shipyards. The Government requires some 300 ships to be replaced within the next fifteen years. Out of 772 American-flag ships totalling 7,300,000 tons only 16 per cent were built since World War II. The average age of U.S. freighters is twelve years. The work horse of the tanker trade, the " T-2," is rapidly reaching obsolescence. There is the potential business and the willingness to do business in the shipbuilding industry. It all adds up to a healthy situation for, at least, the next fifteen years.

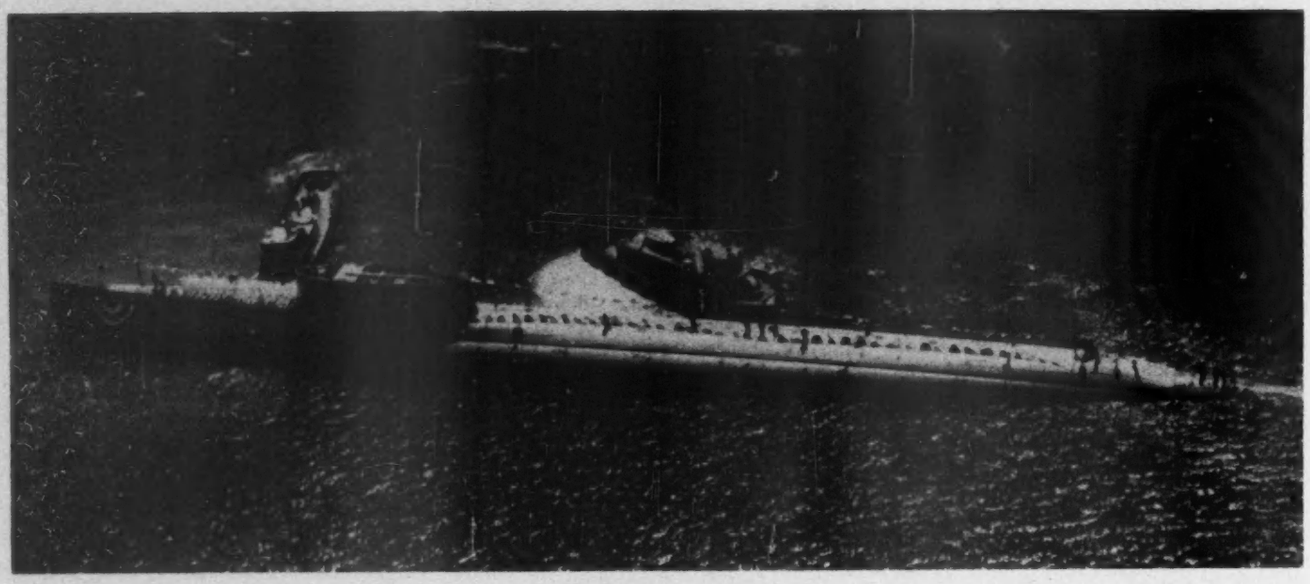
Full Operation of Oak Ridge Research Reactor

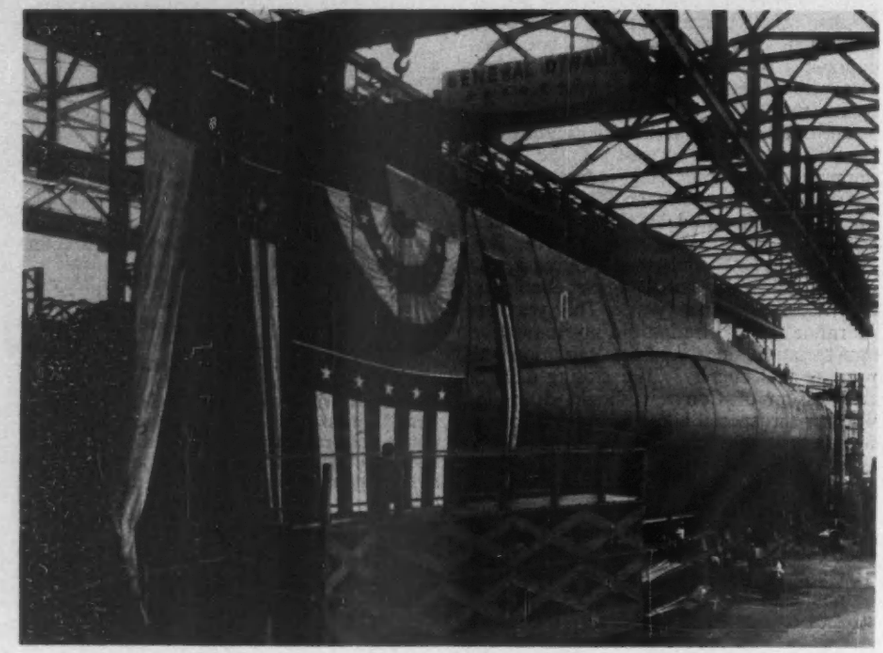
THE new research reactor at the Oak Ridge National Laboratory has now been successfully operated at its design power level of 20MW of heat. The so-called Oak Ridge Research Reactor (ORR), which was described in our issue of May 23, was brought to design power on May 29 after the power level was raised in incremental steps over a period of several days during operational tests. The reactor was designed to operate normally at 20MW, but can be operated at 30MW during some periods to meet the needs of the experimental programme. The ORR went " critical " on March 21 and pre-operational testing has been under way since that time. The testing programme included an evaluation of safety factors associated with all the aspects of design.

The ORR has the highest power level of the six reactors currently in operation at the laboratory. The reactor represents a major engineering advance over previous research reactors of the materials testing reactor type since it achieved extremely high neutron fluxes at only a fraction of the cost of previous reactors of this class. The ORR is a prototype for similar research reactors which are now being built in various parts of the world. The new pile will be used for fundamental research and engineering studies. The research programmes to be carried out in connection with the reactor will include engineering studies on the effects of nuclear radiation, basic studies on the properties of metals, alloys and ceramics, and experiments involving neutron spectroscopy. The reactor also will be used for the production of both short and long-lived isotopes.

The reactor facility includes a hot cell at one end of the storage pool so that irradiated materials may be moved under water from the core region directly to the cell for handling. The ORR is a heterogeneous reactor, moderated and cooled with demineralised water. It has an average flux greater than 1×10^{14} neutrons per square centimetre per second, and has a beryllium-reflected core which utilises fuel elements of uranium-aluminium alloy clad with aluminium. The reactor is housed in a building situated in the laboratory near the Oak Ridge Graphite Reactor and the Low Intensity Test Reactor. The design of the control room for the ORR provides for the future operation of the three reactors from the control room of the ORR.

ATOMIC POWERED SUBMARINE U.S.S. "TRITON"





The large atomic-powered radar picket submarine U.S.S. "Triton" was launched on Tuesday, August 19, and is shown, ABOVE, afloat on the Thames River, and, to the LEFT, on the ways ready for launching from the shipyard of the Electric Boat Division of the General Dynamics Corporation at Groton, Connecticut. The ship, which was laid down in May, 1956, has a length of about 447ft and a surface displacement of approximately 5900 tons, and will be propelled by a two-shaft arrangement of nuclear reactors at a speed sufficient to ensure that the submarine will be able to maintain station with aircraft carriers and destroyers—that is, over 30 knots. High underwater speed, combined with long endurance, are intended to enable the submarine to carry out picket duties at long range, when the ship will surface and then use her detection equipment to obtain early warning of any attack being mounted, so as to alert home atomic striking forces, and later use her direction radar to guide intercepting forces in defence

New Titanium Alloys

THE Titanium Division of the Crucible Steel Company of America (formerly Rem-Cru Titanium Inc.) has recently announced the development of three new titanium alloys. They are the result of an intensive study of numerous titanium alloy systems and are intended to meet the requirements of the aircraft industry for an easily formable, yet high strength, alloy. All three are of the solution treat and age type, and they are now in limited production in a number of forms.

The alloys have been designated B.120.VCA, C.115.AMOV and C.105.VA, and brief details of their composition and properties are given below.

B.120.VCA.—This alloy differs from earlier titanium alloys in that its structure is essentially beta phase. This provides a high degree of formability in the solution treated condition, but permits the attainment of high strength levels by subsequent ageing. The nominal composition of the alloy is 13 per cent V., 11 per cent CR., 3 per cent Al., and it is already in pilot production in billet and as sheet and wire. Solution heat treatment is carried out at approximately 760 deg. Cent., followed by ageing at 450–480 deg. Cent. At the moment a rather lengthy ageing treatment is required, but efforts are being made to develop an accelerated treatment. In the aged condition the alloy is stable for long periods of time at temperatures up to 320 deg. Cent.

A wide range of mechanical properties can be obtained from the alloy by suitable adjustment of the heat treatment, in the solution treated condition; a typical room temperature ultimate tensile strength would be 60 tons per square inch, increased to 85 tons per square inch by subsequent ageing. Even higher tensile strengths, of the order of 105 tons per square inch, can be obtained by the adjustment of the ageing treatment, but at the cost of some loss in ductility. Elevated temperature properties are not yet completely evaluated, but a figure of 78 tons per square inch is quoted for the ultimate tensile strength at 300 deg. Cent.

The comparatively low yield strength and good bend ductility of B.120.VCA in the solution treated condition give it excellent formability, and we are advised that in general any forming operation which is performed on the commercially pure grade A.70 can also be carried out on the new alloy. A noteworthy feature of B.120.VCA is its ability to be cold-headed, a property which gives it a large potential use for rivets and bolts. The alloy can also be welded in the solution treated condition, although further work is required on the ageing of the weld and parent metals.

C.105.VA and C.115.AMOV.—Both these alloys are of the alpha-beta type, the former having a nominal composition of 16 per cent V, 2½ per cent Al, and the latter 4 per cent Al, 3 per cent Mo, 1 per cent V. C.105.VA is characterised by ease of forming in the solution treated condition, and maintains good properties up to 420 deg. Cent. Beyond that temperature its creep rate is rather high. It is also weldable in the solution treated condition. C.115.AMOV, on the other hand, is less easily formed than either C.105.VA or B.120.VCA, but it does possess excellent elevated temperature and creep properties up to at least 420 deg. Cent. This alloy is not recommended for welding.

In particular, it is claimed that high strength, short time properties at present demanding precipitation hardening stainless steels, may now be achieved by the beta alloy B.120.VCA.

The Titanium Division of the Crucible Steel Company of America is represented in the U.K. by Henry Gardner and Co., Ltd., 2, Metal Exchange Buildings, Leadenhall Avenue, London, E.C.3.

Tungsten Carbide Tooling and Spraying Developments

A NEW design of boring bar and several other new styles of tools utilising the "throw-away" insert principle were recently announced by Kennametal Incorporated, of Latrobe, Pennsylvania. Since the introduction of the firm's "throw-away" tooling several years ago, the principle has been extended to milling cutters, boring bars, profiling styles for tracer lathes and other special designs, until the line now includes approximately fifty styles available in more than 250 tools. The latest "Kendex" tool is an adjustable boring bar that accommodates three individual heads to provide a boring diameter range from 2¼in to 3¾in. Each head provides a ¼in diameter adjustment. The new bar incorporates a simple assembly which is attached to a heat-treated alloy steel bar. Standard precision ground "throw-away" inserts, chip breakers and shims, as used in other tooling, are used with the boring heads to provide interchangeability, simplify stocking, and reduce inventory investments.

The firm has also developed the "Kendex" encased boring bar, a new design to take advantage of the high rigidity of Kennametal compositions for boring deep holes as well as to permit the use of harder grades of carbides to cut high-tensile steels. These advantages have been available for many years in smaller bars made of solid carbide. The new design now makes it economical to realise the same advantages of tungsten carbide on larger sizes of bars. The Kennametal encased bars being offered are up to 16in long with bore diameters from 1½in to 3 1/16in. The centre core of the new bar is encased or surrounded with a Kennametal sleeve that provides a degree of rigidity approaching that of a bar of solid carbide. As the new design concentrates the Kennametal carbide in the area of the greatest stress, maximum benefits are obtained with a minimum amount of the material to provide sufficient rigidity to overcome chatter, weaving and drag-out scoring in order to obtain accurate dimensions, straight holes and smooth finishes as required in precision boring operations. The cutting head is equipped with triangular or square inserts, chip breakers and shims as used on standard single-point turning tools to provide the utmost interchangeability in "Kendex" tooling.

The top part of the accompanying illustration shows the contrasting surface finishes on two portions of a 6¾in section of S.A.E. 1020 steel pipe. The rough surface in the foreground resulted when a conventional steel boring bar was used. The adjacent surface was obtained with a "Kendex" bar encased by a sleeve of Kennametal to provide greater rigidity. Both cuts were made with a 7½in bar overhang on a 16in "American Pacemaker" centre lathe under identical conditions; 0·005in feed, 400 surface feet per minute, and 0·015in depth of cut. The Kennametal sleeve (lighter portion of bar in lower part of photograph) extends to within inches of the insert.

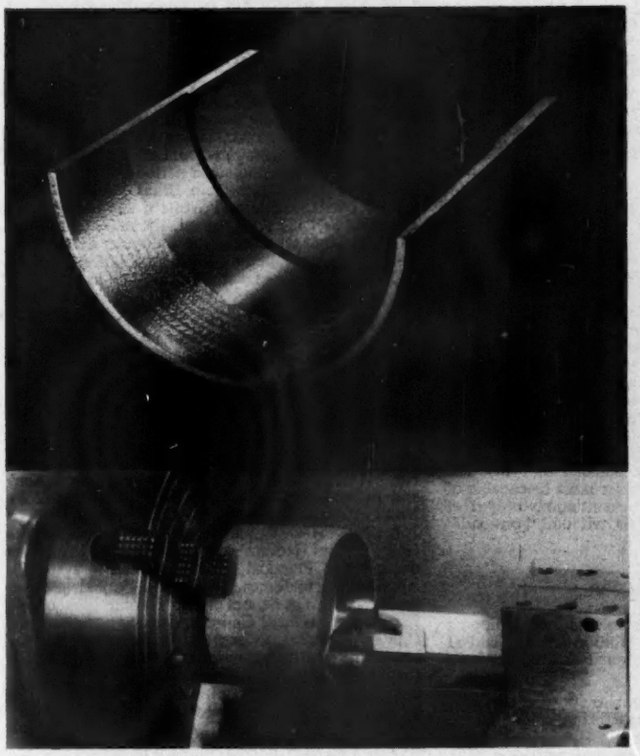


Fig. 1—Contrasting surface finishes obtained in boring operations with plain and special carbide-encased boring bar are seen enlarged above

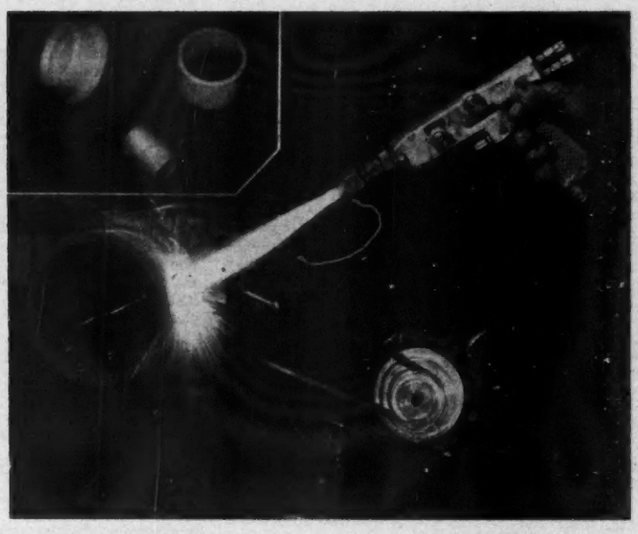


Fig. 2—Application of "Kenspray" tungsten carbide surface coating with metal spraying gun; coated parts shown in insert

The company has also announced its "Kenspray," a new hard surfacing powder with a high content of tungsten carbide that can be applied to steel parts by metal spraying techniques. The powder is said to provide a hard surface possessing properties that closely approach the maximum wear qualities of cemented tungsten carbides. With the new powder, irregular shapes and flat surfaces can be easily coated, the size and shape being limited only by the accessibility required by the spraying equipment. As only a relatively thin coating is needed for wear-proofing, "Kenspray" hard surfacing requires less material, can be applied more quickly and provides a more uniform, defect-free surface than can be obtained with conventional welding methods and materials. The surface coatings can be controlled from 0·010in to 0·090in thickness.

The tungsten carbide content of "Kenspray" also provides high hardness and resistance to erosion as required by machine components and equipment used in the food, chemical, petrochemical and other processing industries. The powder can be applied quickly to steel parts by hand-held or mechanically-held metal spraying equipment. The part and the coating are then heated by an oxy-acetylene torch or in a furnace to fuse the hard surfacing deposit to the base metal. Because of high hardness the surfaces cannot be machined but can be ground with diamond or silicon carbide wheels where close tolerances are required.

American Grant for Norwegian Research Reactor

THE United States Government will contribute 350,000 dollars toward the cost of a nuclear research reactor project being undertaken by the Institute for Atomenergi (I.F.A.), an agency designated by the Norwegian Government for research and development in nuclear energy. This is the sixteenth grant to be made as a result of President Eisenhower's Atoms-for-Peace offer in June, 1955, to assist co-operating countries in the acquisition of nuclear reactors. The funds are made available to the Commission by the U.S. International Co-operation Administration from Mutual Security Programme funds and will be transferred to the Government of Norway upon completion of the project, scheduled for the summer of 1960. The reactor is a zero-power pool facility fuelled with natural uranium and moderated and cooled with heavy or light water. Fabrication of the reactor and construction of the buildings will be handled by the I.F.A. or by Norwegian firms. Some of the equipment for the reactor is expected to be purchased from American firms. Five tons of heavy water to be used as a moderator will be bought from the United States. The I.F.A. will build the reactor at Kjeller, 20 miles north-east of Oslo. The general supervision of the operation of the reactor will be by the Joint Establishment for Nuclear Energy Research (JENER), a co-operative research organisation created by The Netherlands and Norway in 1951. The facility will be used to obtain information on factors that influence the physics and engineering of reactor calculations and design, particularly as they relate to the boiling water reactor. In addition, the Reactor School, established by JENER at Kjeller, will use the facility to train Dutch and Norwegian students in nuclear science and engineering. The reactor will be available to graduate students in reactor physics at the Technical University in Trondheim. The zero-power project will use existing laboratories, machine shops and offices. The cost of the reactor and ancillary facilities has been estimated by the Norwegian Government to be in the neighbourhood of 800,000 dollars.

Personal and Business

Appointments

MR. K. F. CRAYFORD has been appointed sales manager of the Government and industrial valve division of Mullard, Ltd.

FAWCETT PRESTON AND CO., Ltd., announces that Captain R. L. Jordan has been appointed a director and Mr. A. J. Taylor, contracts manager.

SHORT BROTHERS AND HARLAND, Ltd., has appointed Mr. G. A. A. Houlton, A.M.I.Mech.E., as engineer-in-charge, straddle carrier project.

MR. WILLIAM M. FRAMES has been appointed chairman of the International Nickel Company S.A. (Proprietary), Ltd., South African subsidiary of the International Nickel Company of Canada, Ltd.

MR. S. H. JONES states that he has resigned his position with D. Napier and Son, Ltd., and has joined Henry W. Peabody (Industrial), Ltd., as deputy to the director in charge of the Ransburg division.

PLOWRIGHT BROTHERS, Ltd., has appointed Mr. H. Gibson as manager of its coal preparation and carbonisation division, with offices at 197, Knightsbridge, London, S.W.1 (telephone, Knightsbridge 2525–7).

DEWRANCE AND CO., Ltd., announces the appointment to the board of directors of Sir Francis Evans and Mr. L. W. Cole, to fill vacancies created by the resignation, at their own request, of Admiral Sir Cecil Harcourt and Mr. Hector McNeil, M.I.Mech.E., M.I.E.E.

THE BRITISH TRANSPORT COMMISSION states that Mr. J. H. Jellett, M.I.C.E., has been appointed chief docks engineer at Southampton. This appointment follows reorganisation as a result of the retirement of Mr. E. S. Ely, M.I.Mech.E., from the position of docks mechanical and electrical engineer.

SAMUEL FOX AND CO., Ltd., a subsidiary of the United Steel Companies, Ltd., states that Mr. H. Morley is to become general-works manager on September 9. He succeeds Mr. J. D. Joy, who has been appointed a director and general works manager of Appleby-Frodingham Steel Company. Mr. C. M. Slocombe, at present director and chief engineer of Samuel Fox and Co., Ltd., has been appointed director of engineering, and Mr. J. Hammond becomes chief engineer. Mr. H. J. Strong is joining the company to work with the chief engineer, with a view to becoming works engineer on January 1, 1959.

Business Announcements

THE SCIENTIFIC FILM ASSOCIATION has moved to 3, Belgrave Square, London, S.W.1 (telephone, Belgravia 6188).

KELVIN AND HUGHES, Ltd., has moved its executive offices to Empire Way, Wembley, Middlesex (telephone, Wembley 8888).

THE HOTPOINT ELECTRIC APPLIANCE COMPANY, Ltd., states that its title will be changed on September 1 to A.E.I.-Hotpoint, Ltd.

MR. G. FOWLER, production controller of Simmonds Aerocessories, Ltd., is visiting the company's agents in Norway.

BELL'S ASBESTOS AND ENGINEERING (HOLDINGS), Ltd., states that it has acquired the whole of the share capital of Clive Skinner (Proprietary), Ltd., Melbourne, Australia.

SAMUEL FOX AND CO., Ltd., a subsidiary of the United Steel Companies, Ltd., announces that, with effect from September 1, its research department will be known as the metallurgical department.

GLOBE PNEUMATIC ENGINEERING COMPANY, Ltd., Romford, Essex, has appointed Robert Kelly and Sons, Machine Tool Division, Newington, Liverpool, 1, as sole sales and service agents in the Lancashire and Cheshire area.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd., announces that as from September 1, its advertising department will be transferred from 95, Aldwych, London, W.C.2, to 51–53, Hatton Garden, London, E.C.1 (telephone, Chancery 6822).

PROFESSOR P. V. DANCKWERTS, Professor of Chemical Engineering Science at Imperial College, London University, is to lecture in Mexico, from August 18 to 26, on some of the aims and achievements of the United Kingdom in the field of atomic energy.

G.W.B. FURNACES, Ltd., Dudley, Worcs, states that it has appointed Sheppard and Sons, Ltd., Bridgend, Glamorgan, to represent it in the South Wales area for the sale of low tension control gear from 10–1400A a.c. or d.c., and for complete centralised control systems and panels.

MR. P. W. PERKINS, the resident representative of F. Perkins, Ltd., in Central America and the Caribbean, will in future be based in the United States instead of Jamaica. His duties will then also include representing F. Perkins (Canada), Ltd., in the southern states of the U.S.A.

THE FAIREY AVIATION COMPANY, Ltd., announces that it has agreed with the Kaman Aircraft Corporation, of Bloomfield, Connecticut, the terms of a licence for the manufacture and sale of the Fairey Rotodyne vertical take-off air liner in the United States. The agreement is subject to the approval of the Governments of Great Britain and the U.S.A.

Contracts

JOHN LAING AND SON (CANADA), Ltd., has been awarded a contract for further road construction in British Columbia on the Trans-Canada Highway. The contract, worth about 2,000,000 dollars, is for a 7½-mile section through Revelstoke National Park in the Rocky Mountains.

AUSTRALIAN ELECTRICAL INDUSTRIES PTY., Ltd., a subsidiary of Metropolitan-Vickers Electrical Company, Ltd., has received a contract, valued at nearly £4,500,000, from the State Electricity Commission of Victoria, Australia. This contract is for turbo-generator plant and other equipment at the Yallourn power station. It is stated that over £2,000,000 worth of the work will be carried out in the United Kingdom.

THE STATE ELECTRICITY COMMISSION OF VICTORIA, AUSTRALIA, has awarded a contract valued at over £5,000,000 to Babcock and Wilcox of Australia, a subsidiary of Babcock and Wilcox, Ltd. More than a fifth of the work will be executed at the United Kingdom headquarters of the company. The contract is for boiler plant for the Yallourn "E" power station. It includes two boilers suitable for operating continuously with raw brown coal. Each will have an output of 950,000 lb of steam an hour at a working pressure of 1600 lb per square inch gauge and a temperature of 1060 deg. Fah. when supplied with feed water at a temperature of 420 deg. Fah. and fed with raw Yallourn brown coal having a moisture content of up to 68 deg. Fah. The new plant will have two brick-lined self-supporting reinforced concrete chimneys with a base diameter of 34ft. The contract stipulates that the boiler must be capable of maintaining for 8000 hours a continuous output of 950,000 lb of steam an hour without "on-load" cleaning.

Miscellanea

FISHING EXHIBITION.—The International Shipping and Commercial Fishing Exhibition will be held at the Pavilion Site, Corporation Field, Hull, from September 11 to 17.

MILD STEEL ELECTRODE.—An iron powder electrode known as "Ferrolux," is now being manufactured by Quasi-Arc, Ltd., for the high-speed welding of mild steel in the flat and horizontal positions. The electrodes can be used with a.c. or d.c. welding plant and are lightly tipped with a special composition to ensure instantaneous arc starting. They are made in 18in lengths and from 10 S.W.G. to ¼in diameter.

NEEDLE BEARINGS.—A technical manual has been issued by I.N.A. Needle Bearings, Ltd., Dafen, Llanelly, Carms, entitled "Needle Cages and Needle Bearings." It is particularly intended for the assistance of designers and users of needle bearings, and deals in detail with various constructions of the bearings, their capacities, applications, lubrication, maintenance and design requirements for their installation.

NYLON EXHIBITION.—The Plastics Division of Imperial Chemical Industries, Ltd., intends to hold three exhibitions in September and October to illustrate the industrial uses of nylon. The first exhibition will be held in the Chamber of Commerce Assembly Room, Birmingham, on September 23 and 24, the second at the Angel Hotel, Cardiff, on October 14 and 15, and the third at the Grand Hotel, Charing Cross, Glasgow, on October 29 and 30.

WHITE METAL BEARINGS.—A new plant installed by the Phosphor Bronze Company, Ltd., Bradford Street, Birmingham, 5, incorporates the "Kolene" method of preparing bearing backs or halves, together with centrifugal lining machines for handling bearings up to 20in outside diameter. It is pointed out that the preparation process provides such a reliable surface for lining cast iron and other metals with white metal that the practice of machining reverse taper keys into the metalled faces of cast iron bearing halves has been discontinued. The "Kolene" cleaning process was described in our issue of July 6, 1956.

S.B.A.C. EXHIBITION.—The 1958 Flying Display and Exhibition of the Society of British Aircraft Constructors will include the following aircraft which have not appeared before: the Short S.C.1 v.t.o. research aircraft (static park), the Fairey "Rotodyne" v.t.o. air-liner prototype, the Saunders-Roe "P.531" turbine helicopter, the Westland "Westminster" twin-turbine utility helicopter, the Bristol "192" twin-turbine military helicopter, and the Blackburn "N.A.39" naval strike aircraft. The Exhibition is open to the public on Friday, Saturday and Sunday next.

FUEL EFFICIENCY EXHIBITION.—The fifth Industrial Fuel Efficiency Exhibition will be opened in the National Hall, Olympia, London, on Wednesday, September 24, by Earl Attlee, and will remain open until Friday, October 3. The theme of the exhibition is "Greater Productivity at Lower Cost," and a series of technical meetings has been arranged, to be held on the mornings of Thursday, Friday and Tuesday, September 25, 26 and 30, and of Wednesday, October 1, at which papers will be presented covering the economic application of fuel in all its aspects.

OFFICE MACHINERY EXPORTS.—Sales of British office machinery to Australia during the first half of the year jumped 40 per cent to over £2,000,000, so offsetting a drop of £300,000 to the U.S.A. and Canada and enabling the industry to achieve a new six-month export record. Shipments to the industry's biggest customer amounted to £2,096,269 compared with £1,486,654 in the same period last year, while South African imports from Britain went up from £785,663 to £832,592 and Western Germany's from £304,592 to £524,179. In all, the office equipment industry exported during the half-year £13,823,219 of its products including stationery, office furniture and safes, compared with £13,734,046 in the same period last year.

SCHOOL OF GAS TURBINE TECHNOLOGY.—Power Jets (Research and Development), Ltd., has announced the closing of the School of Gas Turbine Technology at Farnborough, to become effective on December 12 this year at the conclusion of No. 152 Introductory and Practical Course. The numbers of students passing through has now dropped to a level such that it is considered no longer economic to run the courses. The following courses will be held: No. 149 "International" Course on Aero and Industrial Gas Turbines (September 8 to 26); No. 150 Aero Engine Design Course (October 6 to 24); No. 151 Design and Applications of Industrial Gas Turbines (November 3 to 21); No. 152 Introductory and Practical Course (December 1 to 12). Applications for enrolment should be addressed to the Principal, The School of Gas Turbine Technology, Farnborough Place, Church Avenue, Farnborough, Hants. Most of the lecturing in the school has for some time past been the responsibility of engineers in the Power Jets Consultancy Department. This department remains available for advice on gas turbines and rotary compressors.

NEUTRON DETECTORS FOR REACTOR CONTROL.—We are informed that two neutron detectors, capable of operating efficiently at temperatures up to approximately 200 deg. Cent., have been developed by Plessey Nucleonics, Ltd. They are the "PNI 1025," a three-electrode ionisation chamber incorporating gamma compensation, and the "PNI 1026," a two-electrode version. Both detectors can operate at the ambient temperatures of the core or shielding for long periods without attention. They have the minimum possible gamma sensitivity consistent with adequate neutron sensitivity, and after operation at high neutron fluxes provide the minimum possible current from residual activities in their structural materials. The main components of both detectors are of highly pure aluminium. Internal insulators and electrode supports are of alumina and the vacuum lead-through seals are of the ceramic bonded to metal. This form of construction provides rigid mounting of the electrode assembly independently of the vacuum seals and cable terminations. The aluminium base of the chamber shrouds the vacuum seals and carries the cable terminations. Detectors are tested to an internal pressure of 100 lb per square inch before filling. Neutron-sensitive coatings of either natural or enriched boron can be provided. The chambers are normally filled with hydrogen at pressures of 25cm, 75cm or 225cm Hg. Although the chamber can be operated at up to approximately 200 deg. Cent., the precise upper limit depends on the lower limit of current to be measured and the filling pressure. Polythene-insulated sealed terminations designed to take similarly insulated and sheathed cables are fitted for normal and moderate fluxes and temperatures. The chambers are said to show excellent saturisation characteristics. Minimal stray collection volume results in low gamma sensitivity.

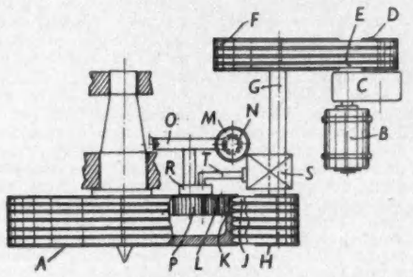
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

MACHINE TOOLS

798,943. November 12, 1954.—MACHINE TOOL DRIVES, Oskar Waldrich, Siegen/Westfalen, Germany.

The invention relates to machine tools in which a heavy workpiece is supported for rotation by plain bearings, such as a roll-grinding machine or a heavy roll-turning lathe. It provides with the main drive an auxiliary drive, which includes a speed change gear of high reduction ratio, which is used solely during starting up. Thus the output and therefore the size of the driving motor can be considerably reduced. As will be seen from the drawing the face plate *A* of



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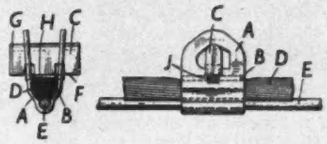
a roll-grinding machine is driven from a main motor *B* through a gear *C*, regulatable within the necessary limits for normal running, and a V groove belt pulley *D*. The drive is conveyed through V belts *E* to a larger pulley *F* and through a countershaft *G* to a small V belt pulley *H* and from there through a further set of V belts *J* to the face plate *A*. As will be seen from the part section on the right-hand side of the face plate the plate has internal teeth *K* with which meshes a toothed wheel *L* which belongs to the auxiliary drive according to the invention. This auxiliary drive comprises an auxiliary motor *M* of low power which through a worm *N* drives a worm wheel *O* to which is fast a small toothed wheel *P*. Both wheels are on a shaft journalled in fixed position while the wheel *L* by means of a link mounting *R* can be rocked around the periphery of the toothed wheel *P* and in this way can be brought into and out of mesh with the teeth *K* of the face plate *A*. The coupling movement is effected by means of an electromagnet *S* which swings the link mounting *R* and thus the toothed wheel *L* through a pull rod *T*.—*July* 30, 1958.

OVERHEAD ELECTRIC TRACTION SYSTEMS

794,517. June 27, 1955.—CLIPS FOR ELONGATED MEMBERS, British Insulated Callender's Cables, Ltd., Norfolk House, Norfolk Street, London, W.C.2. (*Inventors: Joseph Littler and Clifford Edwin Ricketts.*)

The invention relates to a clip for clamping together elongated members one or each of which may be an electric conductor which may be stranded. Referring to the drawing the clip, which consists of three parts, a body *A*, a clamping plate *B* and a cam piece *C* is shown securing together a stranded feeder cable *D* and a dropper wire *E*. The body piece is formed from a single piece of cadmium copper into a V-shape and the lower part of the V is shaped to hold securely the two conductors of different diameters, one above the other. In each arm of the body there is an aperture, the shape of which can be clearly seen from the left-hand view. Through the two apertures in the arms of the body passes the cam piece *C*, which consists of a solid cadmium copper bar of rectangular shape in cross-section except for one side which is semi-circular. In the flat face of the cam piece opposite the semi-circular face there are two recesses which reduce the depth of the cam piece at two points, leaving at the ends two fingers *F* and *G* and in the centre a third projecting part *H*, namely the clamping part. Between the cam piece *C* and the feeder cable *D* is the clamping plate *B* in the form of a cadmium copper strip which fits loosely between the substantially parallel parts of the arms, and is of a length equal to the width of the strip from which the body is made and has integral lugs *J* in the middle of each side which fit into narrow central slots in the arms extending upwards into the apertures of the cam piece. As shown in the drawing the clip is in its closed position. To open the clip the cam piece *C* is rotated through approximately 90 deg. in an anti-clockwise direction by means of a spanner applied to either end. During the first part of this movement one edge of the flat surface of the clamping part *H* of the cam will press down upon the clamping plate and as this edge moves through its lowest position a snap action will be given to the movement of the cam piece. By reason of this snap



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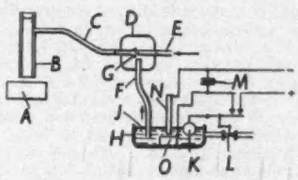
action in its movement, which operates during both the opening and closing movements, the cam piece is securely locked in the position in which it holds the clip closed. When the cam piece is in an idle position it is secured to the body by virtue of the pressure of the diverging arms of the body on the inner surfaces of the fingers *F* and *G*. Modified designs are also shown in the Specification.—*May* 7, 1958.

ELECTRICAL ENGINEERING

787,731. December 31, 1952.—CUTTING ELECTRICALLY CONDUCTIVE MATERIALS, Sparcatron, Ltd., Abbey Yard, Bath. (*Inventor: Dagobert William Alfred Fritz Rudorff.*)

The invention relates to methods and apparatus for cutting electrically conductive materials more especially hard metals such as metal carbides by means of electric spark discharges as described in Specification No. 637,872. In practice water may be used as the liquid medium and a suspension of particles of silicon is contained in the water. A particularly convenient method for producing this suspension is to place a piece of silicon in a bath of water and then to make it the workpiece in a spark cutting process as described in Specification No. 637,872, thus dispersing finely comminuted silicon in the water. In order to maintain constant the amount of silicon contained per unit volume of water, provision may be made to control the dispersal of silicon in accordance with the rate of consumption of water for the purpose of injecting it into the bathing fluid. Such an arrangement is illustrated in the accompanying



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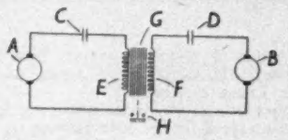
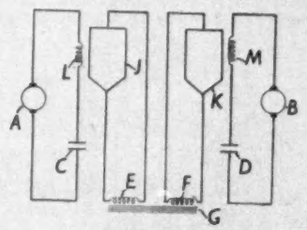
diagrammatic drawing, where *A* indicates a workpiece and *B* a hollow electrode into which is led a conduit *C*. *D* is an injector receiving compressed air through a supply pipe *E* which entrains a liquid spray into the injector through a riser pipe *F*, the compressed air and spray thence passing into the conduit *C* which has a bell mouth *G*. At its lower end the riser pipe *F* is immersed in a bath *H*, the level of water *J* wherein is maintained by a float *K* operating a valve *L*. The float also controls a spark discharge circuit including a capacitor *M* an electrode *N* and a piece of silicon *O*, a spark gap being maintained between the latter in the water bath *J*. The workpiece is connected to a positive pole either in the spark discharge circuit or in another circuit, and a spark gap is maintained between said workpiece and the electrode *B* through which flows a mixture of air and water vapour containing suspended particles of silicon. It will be appreciated that other gas or vapour suspension may be employed and that the vapour may be condensed at the cutting zone after passing through the spark gap and after filtration may be recirculated to the tank *H*.—*December* 18, 1957.

792,627. July 8, 1955.—DETECTING MECHANICAL SLIP, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventors: Donald Windsor Prowse and Geoffrey Edmund Woodliff.*)

The invention relates to a means for detecting mechanical slip, that is transitory discontinuity of mechanical coupling between two members which are normally coupled together, to ensure a fixed speed ratio. Thus the invention is particularly suitable for detecting slip in a rope drive. The invention affords a substantially instantaneous response at all speeds, which is achieved by the provision of an electric circuit arrangement suitable to respond to the instantaneous value of relative acceleration of one member with respect to the other. A signal of sufficient strength suitable to be used for initiating an emergency control if required, is also provided. Referring to the upper drawing tachogenerators *A* and *B* either d.c. (or, if a.c., having their output rectified), are driven normally at equal speeds by two members which are frictionally coupled together. The tachometers are connected through respective capacitors *C* and *D* to two differentially wound coils *E* and *F* mounted on a core *G*, the energisation of which causes closure of contacts *H* and completes a circuit to provide a control initiating signal. When the two tachogenerators rotate at constant speeds no current will flow in either coil, because of the inclusion of a capacitor in each circuit. During periods of normal acceleration, current will flow in both coils because there will be a change in the generated voltages. However, as the members driving the tachogenerators are coupled together, the rate of change of voltages, and therefore of the currents in the coils, will be the same, or in a fixed





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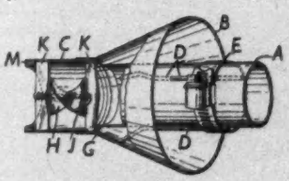
pre-determined relationship, and the coils are wound to produce under such conditions a resultant zero flux, in the core. Thus the relay will not operate. Should there be a relative acceleration of one member with respect to the other, however, there will be a corresponding rate of change of one voltage with respect to the other, and different currents will therefore flow in the two relay coils, producing a resultant flux. Thus sensitivity of the circuit can be arranged so that the relay is operated at a specified current difference, and therefore at a specified relative acceleration. If it is required to detect low values of relative acceleration, the sensitivity of the system can be increased by means of amplifiers. A system employing magnetic amplifiers *J* and *K* controlled by windings *L* and *M* connected to the outputs of tachometer generators *A* and *B* is shown by way of example in the lower view. It is an advantage of this system that it fails to safety, as the relay is arranged to operate immediately in the case of any amplifier failure.—*April* 2, 1958.

INTERNAL COMBUSTION ENGINES

798,960. May 5, 1956.—EXHAUST SYSTEMS, Norman Harold Bradshaw, 425, Redditch Road, Kings Norton, Birmingham, 30.

The invention relates to a device for use in combination with the exhaust system of an internal combustion engine. One object of the invention is to provide a device which will lead to an increase in the power output of the engine by reducing the back pressure in the exhaust system. A further object is to provide a device which will lead to a more thorough scavenging of the burnt gases from the combustion space. Referring to the drawing, the device is shown



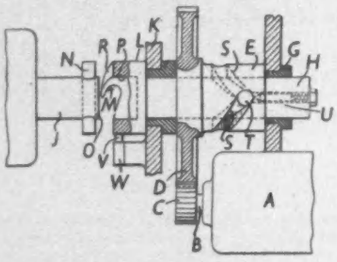
No. 798,960

applied and mounted upon the exhaust tail pipe *A*. The device comprises a frusto-conical member *B* which at its narrower end is connected to an outlet tube *C* arranged coaxially. The device is supported upon the tail pipe *A* by means of three or more spaced support rods *D* which are cranked at their ends and secured to the inner surface of the frusto-conical member *B* adjacent its narrower end. At their

other ends the support rods *D* are secured to an adjustable band clip *E* of the worm and ratchet type. When the device is correctly mounted upon the tail pipe *A*, the inner end of the outlet tube *C* is spaced a short distance away from the outer end of the tail pipe *A* so as to leave an annular passage *G* leading into the outlet tube *C*. Within the outlet tube the helical deflector member *H* is mounted about a central pin *J*, the ends of which are secured to two supporting strips *K* which extend diametrically across the outlet tube. The deflector member consists of a close coiled wire spring which has a number of coils, the ends of the helix being then welded to the supporting strips. For larger size exhaust outlet pipes the device is also preferably fitted, or formed, with a restricting ring such as is shown at *M*. In practice this is found to increase the speed of expulsion of the gases and ensures that the gases come under the full influence of the helical deflector member so as to create the desired flow of the gases. A modified design is also shown in the specification.—*July* 30, 1958.

798,946. April 1, 1955.—STARTING DEVICES FOR ENGINES. Thomas Richard Jones, 28, High Street, Llangefni, Anglesey.

The object of the invention is to provide for a lower take-up speed for the drive between the starter motor unit and the engine shaft; to provide for positive disengagement of the drive when the engine starts, and to minimise, if not completely eliminate, any tendency of the drive to lock solid. In the form of the invention shown in the drawing, the improved



No. 798,946

starter comprises an electric motor *A*, the shaft *B* of which carries a pinion *C* in permanent mesh with a high ratio drive wheel *D*, which is carried by a clutch-operating sleeve *E* held between end bearings (*G*), and embracing an axially slidable clutch shaft *H* which in use as shown is aligned with the engine shaft *J*. This shaft is shown solid, but it may be tubular so that the engine shaft can extend therethrough. The bearings are carried in a suitable frame *K* on which the starter motor *A* may be mounted to provide a unit assembly which is easily mounted on the vehicle. The clutch shaft *H* carries the primary part of the clutch, the complementary part being secured to the engine shaft *J*. As shown, the primary part of the clutch comprises a collar *L* having in its circumference a pin-receiving recess, like a claw *M*, on one face adapted for engaging the complementary clutch part in the form of a pin *N* secured across the engine shaft *J*. When the clutch collar *L* moves in a forward direction, to the left, towards the pin *N*, the engine shaft end *O* enters the collar recess *P* so that both shafts are located axially, and the claw recess *M* on the collar takes up the drive by engaging the pin *N*. As the engine starts, the shaft *J* over-runs the clutch shaft *H*, and the clutch collar *L* moves axially to the right to effect the disengagement of the clutch parts *L*, *M* and *N*. Disengagement is assured by providing the collar *L* with inclined cam surfaces *R* extending from the recess formed by the claw *M*, which surfaces by bearing on the pin *N* as it over-runs with the engine shaft, cause the clutch shaft *H* to be pushed axially to the right into the clutch disengaged position. A drive connection between the clutch-operating sleeve *E* and the clutch shaft *H* conveniently takes the form of two inclined and helically arranged slots *S* in opposite sides of the sleeve. In these slots there works freely the projecting ends of a pin *T* which passes through the clutch shaft *H* and is held in position by a set screw *U*. When the starter motor *A* is operated, the sleeve *E* through the reduction drive of the pinion *C* and high ratio wheel *D*, is driven at reduced speed, and by means of the slots *S*, in the sleeve, bearing on the ends of the pin *T*, causes the frictionally held clutch shaft *H*, to move axially forwardly to engage the clutch. A brake ring or pad *V* carried by a mounting ring *W* on the housing *K* frictionally engages the clutch collar *L* to prevent or limit turning of the shaft *H* until it has moved forward into engagement and to assist in keeping the shaft in the "off" position.—*July* 30, 1958.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

DIMENSIONS OF CARBURETTOR OUTPUT FLANGES

No. 2985 : 1958. Price 4s. 6d. This standard deals with series of carburettor output flanges for future designs. Its use will benefit carburettor and engine manufacturers and engine users, and will minimise size variations of pre-cut joints/gaskets. The 13-page, illustrated publication specifies rationalised ranges of nominal overall dimensions for abutment faces of single- and double-barrel output flanges (with clearance holes for attachment) for motor cycle, automobile and industrial engine carburettors. As metric units are frequently used in the United Kingdom for dimensions of these flanges, both inch and metric units are given, and standard dimensions are shown in bold type. The flanges are divided into five geometrically different groups, and each group contains a range suitable for carburettors with different bores.

BLACKHEART MALLEABLE IRON CASTINGS

No. 310 : 1958. Price 4s. Three grades of blackheart malleable iron castings (B18/6, B20/10 and B22/14) form the subject of this revision of a well-established British Standard last revised in 1947. The chemical composition of the metal of the castings is considered to be of less importance than the mechanical properties. In consequence, compliance with the requirements of the specified tests is to be regarded as the main criterion of the material's "suitability for purpose." The provision and heat-treatment of the test bars are specified, as are tensile test and bend test and hardness requirements; provision is also made for additional tests to be undertaken by arrangement with the manufacturer. Alternative dimensions—based on practice in several other countries—are given. They have been included in order to gain experience with them in the United Kingdom, and to facilitate the exchange of information with other countries.

MACHINE SCREWS AND MACHINE SCREW NUTS (B.S.W. AND B.S.F. THREADS)

No. 450 : 1958. Price 12s. 6d. Although the Unified thread has been steadily gaining popularity since it was first introduced to British industry several years ago, it is recognised that Whitworth threads must inevitably continue in use for a long time to come. This new edition of B.S. 450 has therefore been issued to meet the need for an up-to-date standard for machine screws with B.S.W. and B.S.F. threads. It was evident when the standard came up for review in the immediate post-war period that substantial revision was required to bring it into line with current practice. Although this revision was put in hand at once, its completion was deferred because of the more pressing need to prepare the standard for fasteners for Unified threads. It is of interest to note, however, that when B.S. 1981, "Unified Machine Screws and Machine Screw Nuts," was prepared, the opportunity was taken to include a number of features relating to general practice with a view to incorporating them in B.S. 450, when work on that standard was resumed. Thus, the general requirements in the present standard are in most cases similar to those in B.S. 1981, but, since development is continually occurring in methods of manufacture, further advances in established practice have also been recognised. In addition, the scope has been considerably extended to include all the various types of heads in common use in both slotted and recessed forms.

Launches and Trial Trips

ADMINISTRATOR, closed shelter deck cargo ship; built by William Doxford and Sons (Shipbuilders), Ltd., for the Ruthin Steam Ship Company, Ltd.; length between perpendiculars 450ft, breadth 62ft, depth moulded 39ft 6in, deadweight 9500 tons; five hatches, derrick outfit includes two to lift 70 tons; service speed 15½ knots; Doxford opposed piston oil engine, six cylinders, 670mm diameter by 2320mm combined stroke. Trial, July 22.

VARICELLA, oil tanker; built at the Wallsend shipyard of Swan, Hunter and Wigham Richardson, Ltd., for Shell Tankers, Ltd.; length between perpendiculars 640ft, breadth moulded 85ft, depth moulded 46ft 7in, load draught 34ft 4in, deadweight 33,000 tons; service speed 15½ knots; thirty cargo oil tanks, one main pump room, four 1160 tons per hour Drysdale turbine-driven vertical centrifugal pumps, two stripping pumps; two 425kW, 440V, turbine-driven B.T.H. alternators, one 100kW diesel-driven alternator; one set of double reduction geared turbines built by Wallsend Slipway and Engineering Company, Ltd., 11,000 service s.h.p. at 102 propeller r.p.m. take steam at 600 lb per square inch and 900 deg. Fah. from two Babcock and Wilcox "Selectable" superheat boilers. Launch, July 30.

RED CRUSADER, trawler; built by John Lewis and Sons, Ltd., for the Crusader Fishing Company, Ltd.; length overall 133ft, breadth 25ft 6in, depth moulded 12ft 9in, gross tonnage 274; fish room 6500 cubic feet, electric trawl winch, 150 b.h.p., barrel capacity 800 fathoms 2⅜in warp, 125kW diesel-driven winch generator, two 20kW diesel-driven generators; Widdop G.M.B.7 diesel engine, 640 b.h.p. at 250 r.p.m.—Trial, August 5.

IONIE, refrigerated cargo liner; built by Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., for the Shaw Savill and Albion Company, Ltd.; length overall 512ft, breadth moulded 70ft, depth moulded to shelter deck 41ft 6in, load draught 30ft 9in, deadweight 11,900 tons, gross tonnage 11,000, refrigerated cargo capacity 411,000 cubic feet, general cargo 239,000 cubic feet, service speed 17 knots; two complete decks, six holds, MacGregor hatch covers, one 50-ton, one 25-ton and other derricks to lift 3, 5 and 7 tons; electric winches; four Allen 340kW diesel-driven generators and one 75kW diesel-driven emergency generator; Harland and Wolff two-stroke, opposed piston, eight cylinders, 750mm diameter by 1500mm stroke, 13,300 s.h.p. at 117 r.p.m.—Launch, August 14.

KING HENRY, cargo ship; built at Belfast by Harland and Wolff, Ltd., for the King Line, Ltd.; length between perpendiculars 435ft, breadth moulded 59ft, depth moulded to shelter deck 39ft 9in, gross tonnage 5900, deadweight 9500 tons; two complete decks, five cargo holds, one 50-ton, one 25-ton, six 10-ton, and six 5-ton derricks, twelve electric winches, three 125kW diesel-driven generators, Harland and Wolff-B. and W. single-acting, four stroke diesel engine, six cylinders, 740mm diameter by 1500mm stroke, 3300 s.h.p. at 115 r.p.m.—Launch, August 15.

BRITISH AMBASSADOR, oil tanker; built at Barrow by Vickers-Armstrongs, Ltd., for B.P. Tanker Company, Ltd.; length overall 710ft, length between perpendiculars 665ft, breadth moulded 95ft, depth moulded 51ft, deadweight 42,000 tons on 38ft 8in summer draught, sea speed 16 knots; forty-four cargo oil tanks arranged four abreast, one cargo pump room, three 1000 tons per hour turbine-driven Drysdale centrifugal two-stage cargo pumps, one 1000 tons per hour ballast pump, three 150 tons per hour stripping pumps, main cargo lines 15in bore, Seaguard system of cathodic protection; two 750kW, 440V, 60 c/s turbine-driven alternators, one 200kW diesel-driven alternator; single set of Pametrada double reduction geared turbines, 16,000 service s.h.p. at 105 propeller r.p.m., 17,600 maximum s.h.p. at 108 propeller r.p.m., steam supplied at 600 lb per square inch and 850 deg. Fah. by two Babcock and Wilcox "Selectable" superheat boilers, five-bladed propeller.—Launch, August 16.

BRETWALDA, cargo ship; built by Joseph L. Thompson and Sons, Ltd., for Hall Brothers Steamship Company, Ltd.; length between perpendiculars 421ft, breadth moulded 59ft 6in, depth moulded 38ft 2in, deadweight 11,545 tons on 28ft 6½in summer draught (closed shelter deck); five main holds, six 5-ton and four 10-ton derricks, steam winches; Doxford four cylinder, opposed piston oil engine.—Launch, August 18.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., Sept. 1.—N.E. LONDON BRANCH: Angel Hotel, Ilford, "Safety and the Supervisor," H. E. M. Thomas, 8 p.m. ★ SHEFFIELD BRANCH: Royal Victoria Hotel, Sheffield, Chairman's Address, W. Lewis, 7.30 p.m.

Tues., Sept. 2.—W. LONDON BRANCH: Windsor Castle Hotel, 134, King Street, Hammersmith, W.6, "Electric Furnaces," R. Whittaker, 7.30 p.m.

Wed., Sept. 3.—HALIFAX BRANCH: "Crown" Hotel, Horton Street, Halifax. Showing of 1957 exhibition film, introduced by P. A. Thorogood, 7.45 p.m. ★ MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, 2, "Live Wire Discussions," 7 p.m. ★ N. LONDON BRANCH: Wood Green Town Hall, Wood Green, N.22, "Manufacture and Uses of Mineral Insulated Cables," H. W. M. Barker, 7.45 p.m. ★ PRESTON BRANCH: R.A.F.A. Club, East View, Preston, "The Electrical Contractor in Industry," S. Carwin, 7.30 p.m.

INCORPORATED PLANT ENGINEERS

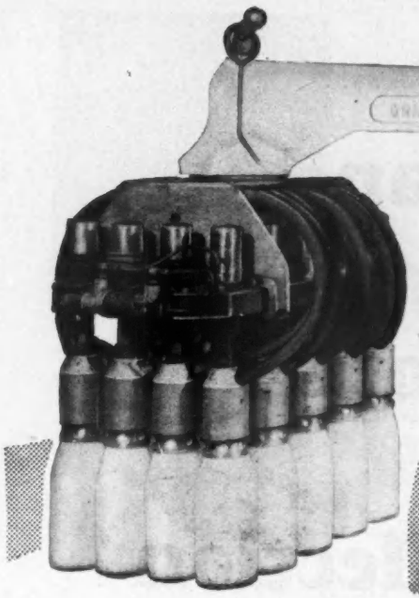
Tues., Sept. 2.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Strand, W.C.2, "Human Relations," R. R. Hopkins, 7 p.m.

Wed., Sept. 3.—LEICESTER BRANCH: Bell Hotel, Leicester, "Some Aspects of Planning and Designing in Industrial and Commercial Buildings," Hugh S. Smith, 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Sept. 1.—LIVERPOOL GRADUATE SECTION: Radiant House, Bold Street, Liverpool, 1, "Press Tools," F. Hallifax, 7.30 p.m.

Wed., Sept. 3.—DUNDEE SECTION: Royal Hotel, Union Street, Dundee, "Problems Associated with Spark Erosion," W. Ullman, 7.30 p.m.



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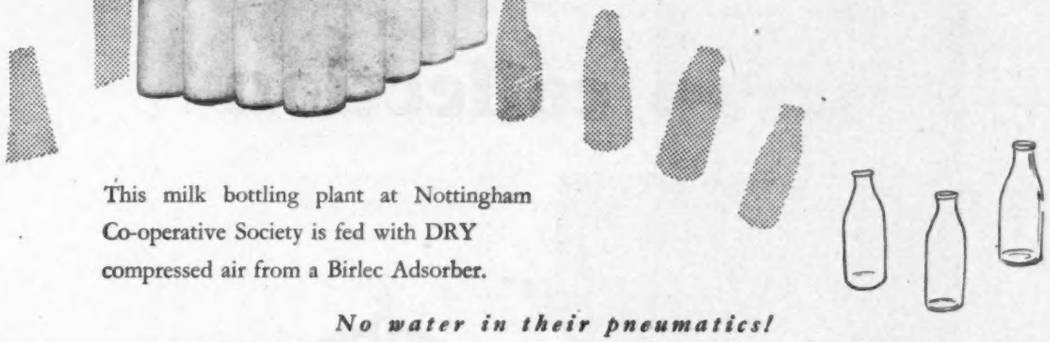

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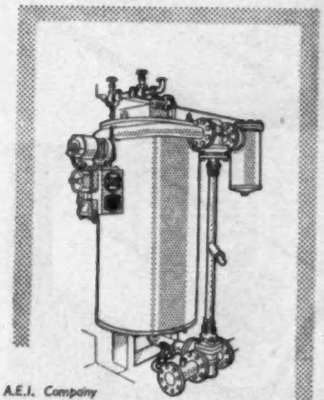

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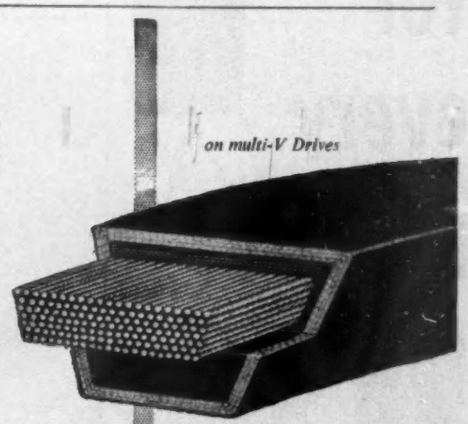

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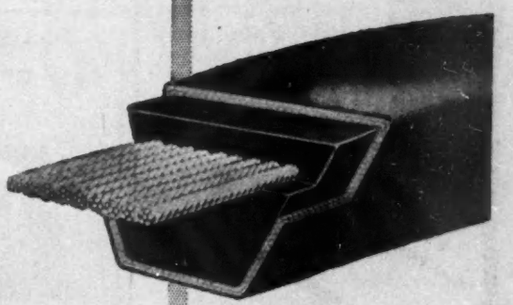

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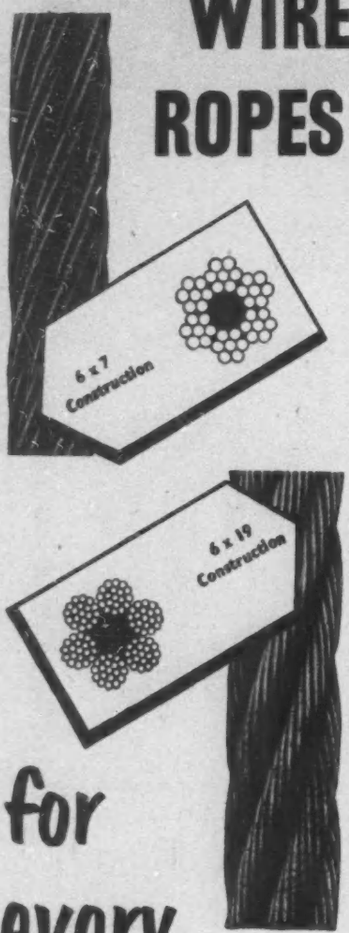

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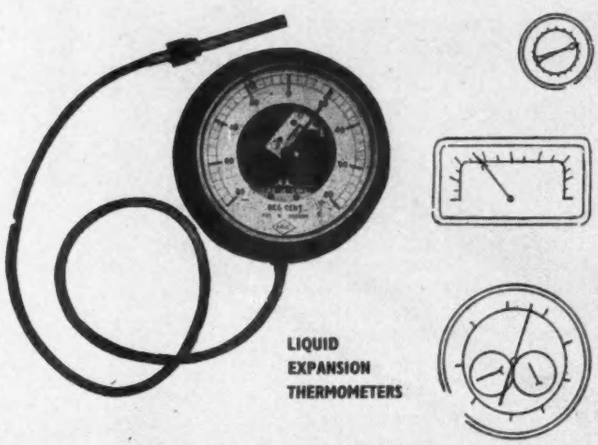

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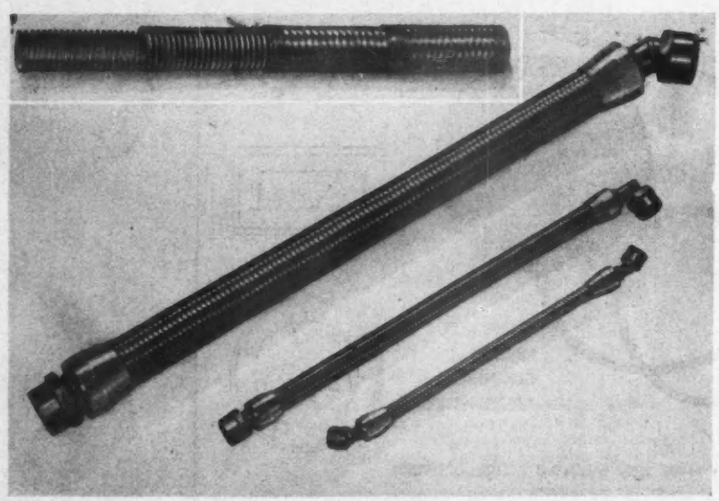

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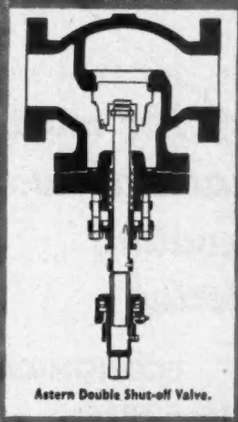

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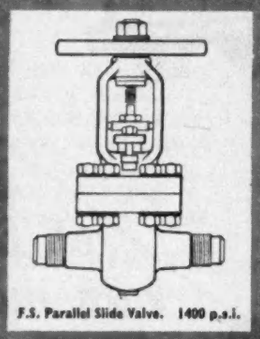

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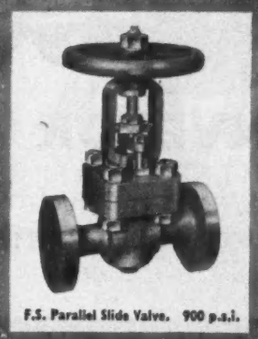
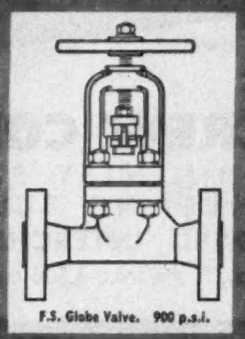


F.S. Parallel Slide Valve. 900 p.s.i.



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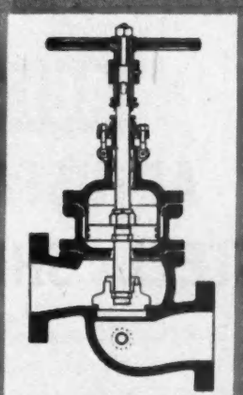

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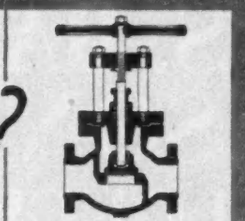
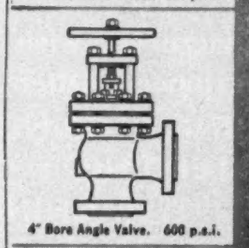
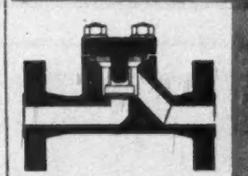


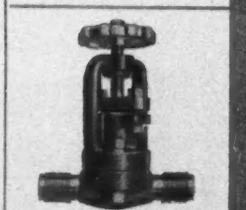
5" Bore Globe Valve. 600 p.s.i.



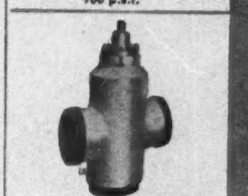
4" Bore Angle Valve. 600 p.s.i.



F.S. Auto. N.R. Valve. 900 p.s.i.



F.S. ¼" Bore Fine Control Valve. 900 p.s.i.



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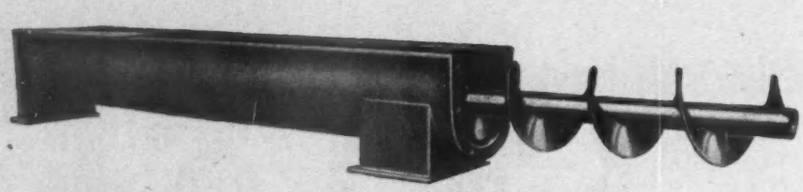

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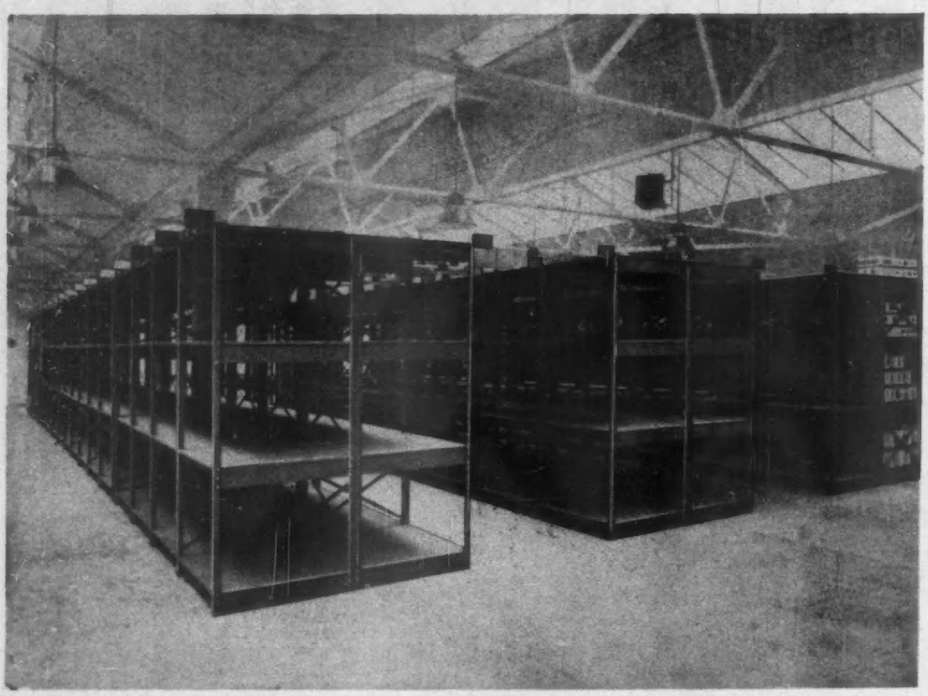

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Feed water that deposits scale on boiler heating surfaces is a prime cause of overheating and subsequent tube collapse. And, remember, the majority of town water supplies, as well as sea-water, are heavy depositors of scale.

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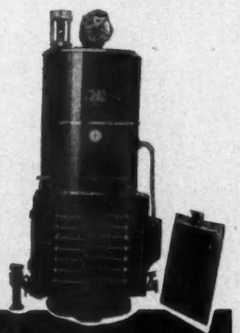

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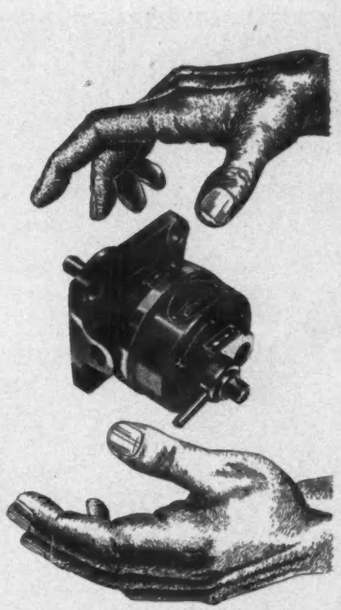

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Paradoxically, the product of human skill is more accurate than human skill itself. This is particularly so in the case of Savery Hydraulic Pumps. Countless thousands of Savery Pumps are in use throughout the world working with precision that neither human skill nor other means can match. Next time you're considering control of motion remember Savery Hydraulic Pumps first. Savery Pumps can be supplied with fixed or variable delivery.

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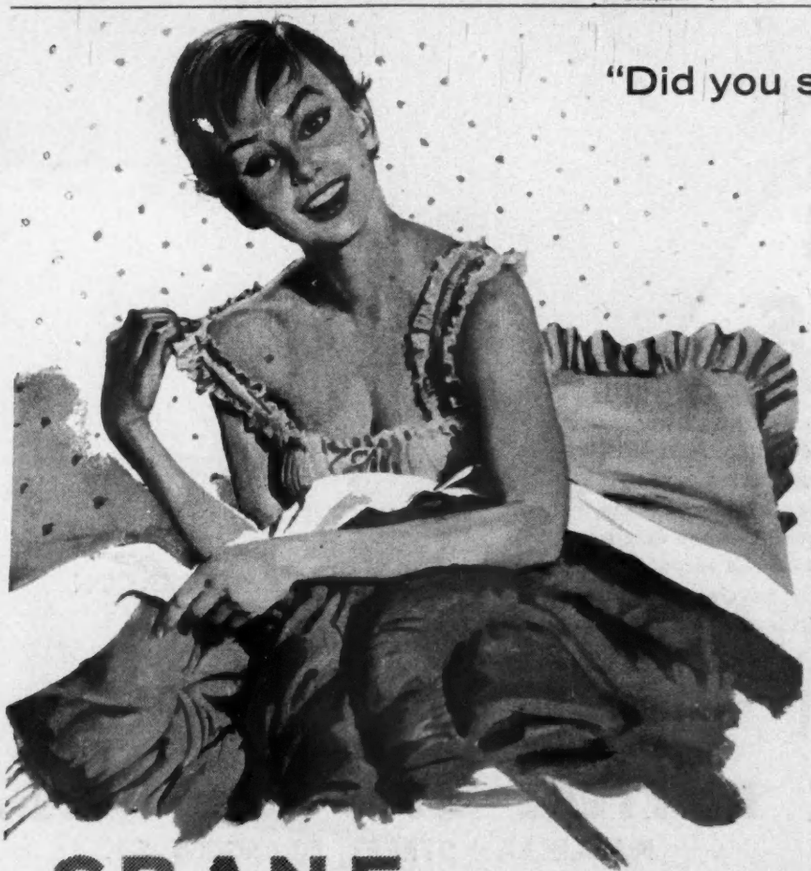
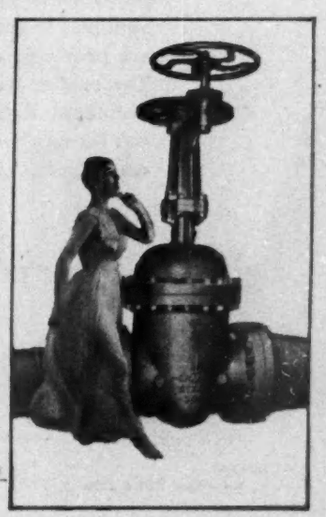


"Did you say Crane giant valves helped to make my nightie?"

THE surprised Miss in the picture finds it difficult to associate her pretty Nylon nightie with Crane giant valves. However, at the British Nylon Spinners factory these valves are performing jobs of vital importance during the early processing stages of the raw materials which go into the manufacture of Nylon. The industries which Crane giant valves serve are varied and numerous . . . and the giant valve is only one among a wide variety of Crane valves for high and low pressures—ranging from ½" to 24"—each with a tradition of reliable, efficient service. Crane's reputation for reliability lies in their high standard of design, production and precision testing methods.

* * * * *

Among the country's largest industries using CRANE giant valves are:—*Esso Petroleum Co. Ltd. · Imperial Chemical Industries Ltd. · 'Shell' Refining & Marketing Co. Ltd. · Reed & Smith Ltd. · British Nylon Spinners Ltd. · Pfizer Ltd. · Firestone Tyre & Rubber Co. Ltd.*



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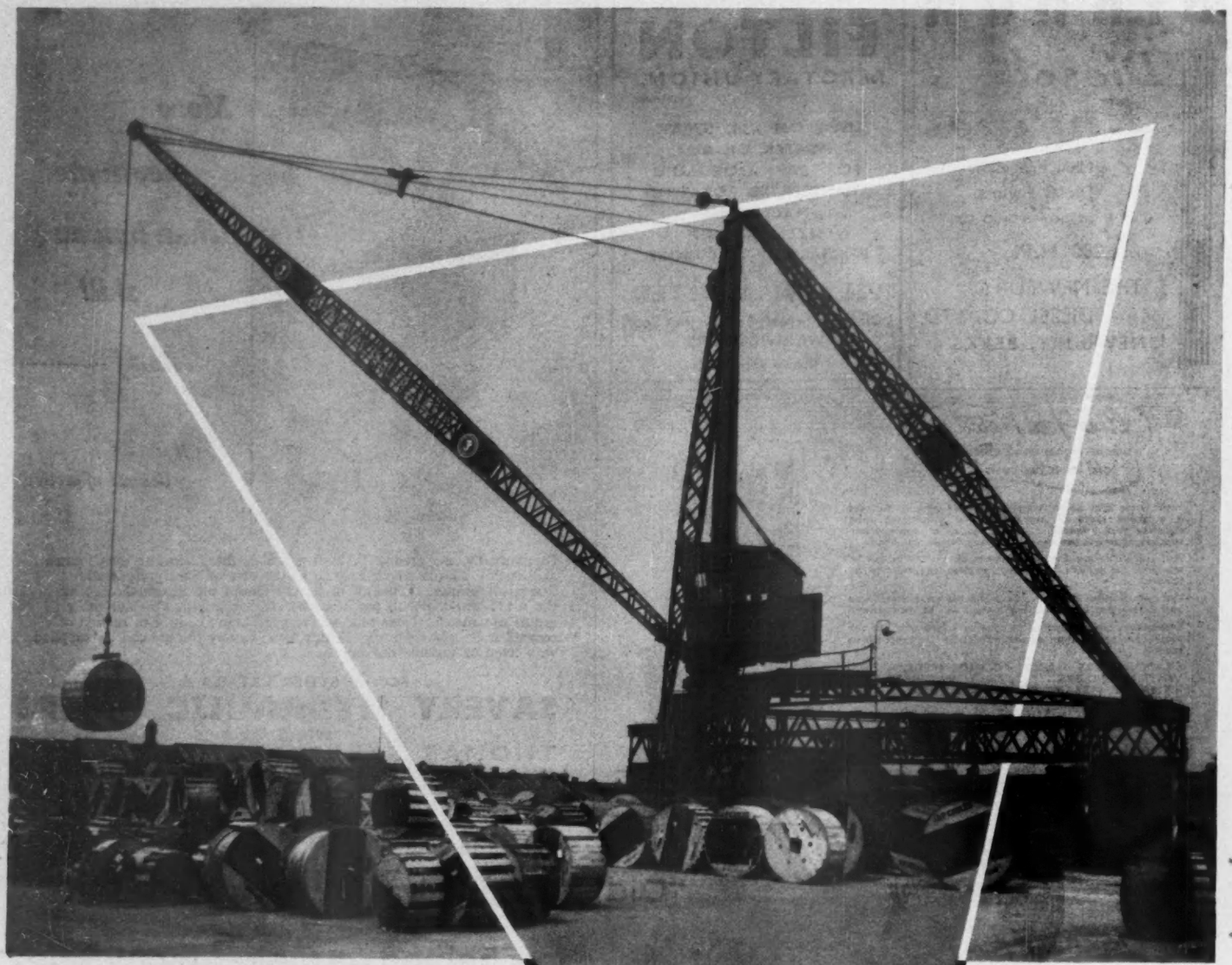

BUTTERS DERRICKS

This crane is a 7-ton electric travelling derrick with a 120 ft. jib, recently supplied to Messrs. Johnson & Phillips Ltd., of London. It is one of the thousands of Butters Derricks which are providing excellent service in industry all over the world. The robust clean construction will be noted, and the excellent visibility. Relatively low towers are used on this model but they can be supplied in heights to give any required clearance, while, of course, a full range of powers and jib lengths is available from standard.

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VERSATILITY
RELIABLE SERVICE
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Builders of fine cranes for all duties.

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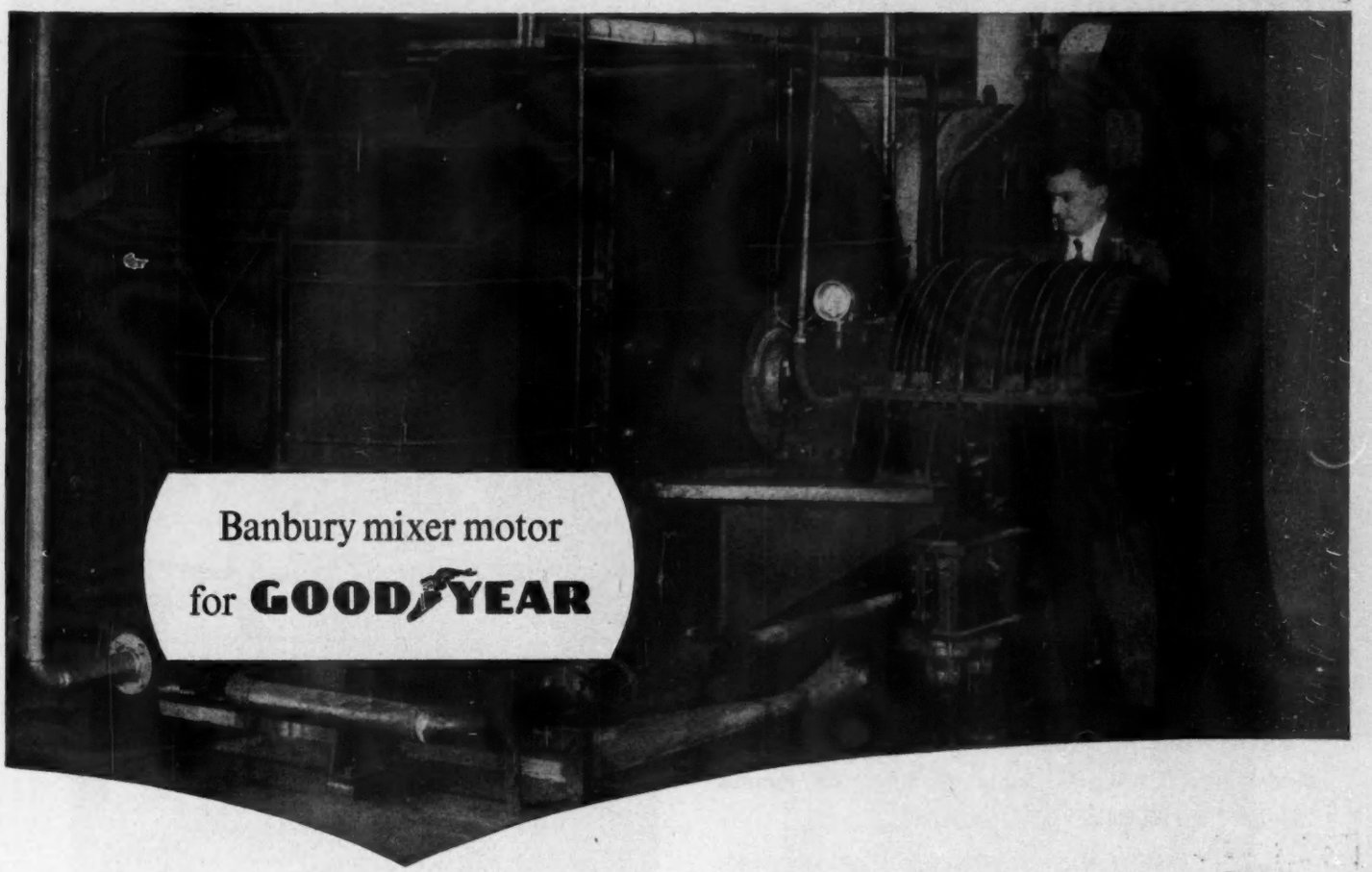
Drives for the Rubber Industry



This 1500 h.p. 6.6 kV 'ENGLISH ELECTRIC' Motor driving a Banbury Mixer at the Wolverhampton Works Extension of the Goodyear Tyre and Rubber Company (Great Britain) Ltd., was specially designed to operate in an atmosphere heavily laden with carbon black.

The machine is of the closed air circuit water cooled type with totally enclosed slip-rings. The shaft and machined joints are sealed to confine the machine "breathing" to filter-ventilated breathers on the slip-ring enclosure and main stator frame.

'ENGLISH ELECTRIC'

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Electrical Plant Sales, Stafford

WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

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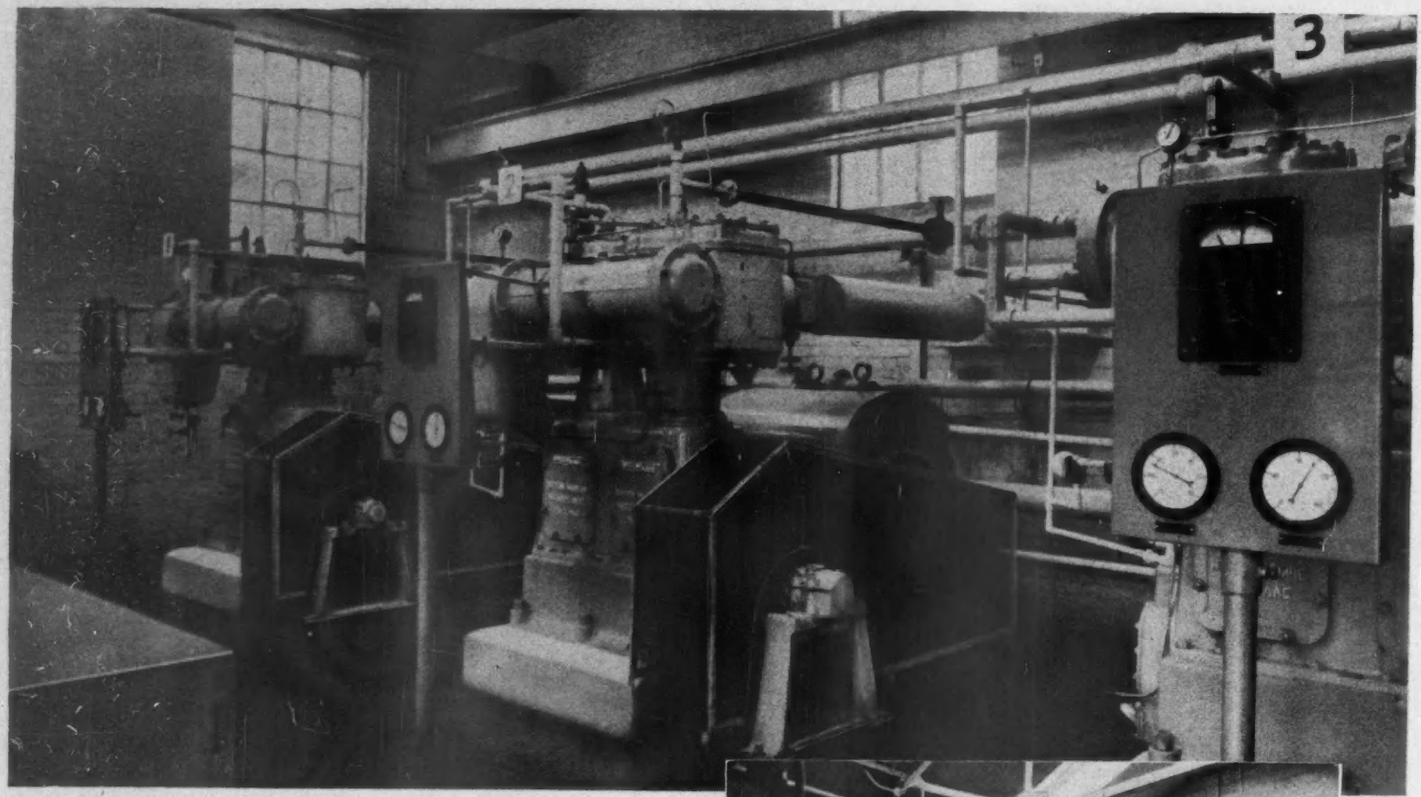


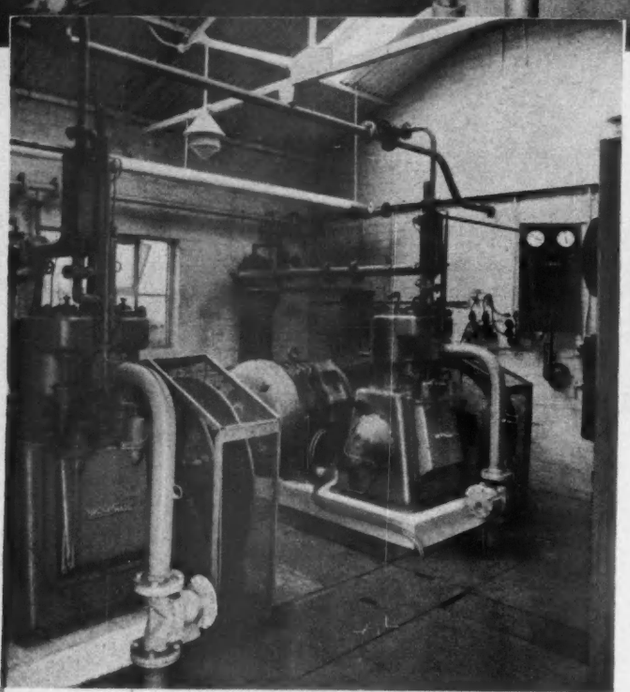
The main plant comprising one T.S.1 and two T.S.1.B. Air Compressors. Total output 1380 c.f.m.

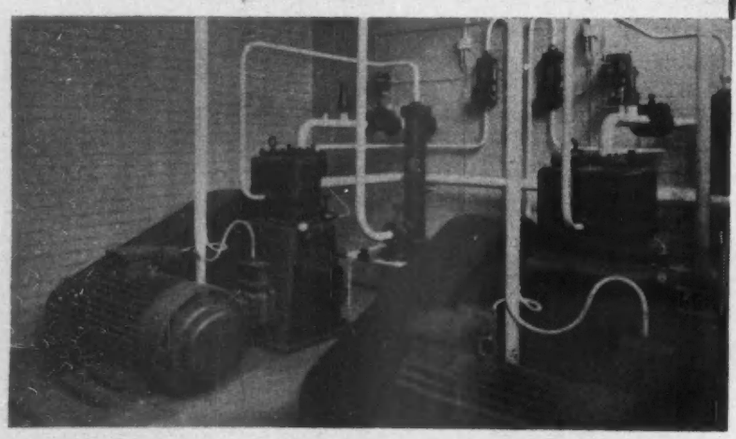
"BROOMWADE" aids I.C.I. Paint Production

"BROOMWADE" pneumatic equipment is widely used at the ICI Works in Slough, where the famous 'Dulux' brand paints are made.

WINGS DAY SEPT. 20th GIVE FOR THOSE WHO GAVE

For an efficient, economical and outstandingly reliable supply of compressed air, organisations throughout the world choose "BROOMWADE".





Above : Two D 23 Compressors for inert gas used in making paints, varnishes and synthetic resins, each delivering 220 c.f.m.

Left : Two D22A Air Compressors in the Technical Service Laboratory, each delivering 100 c.f.m.

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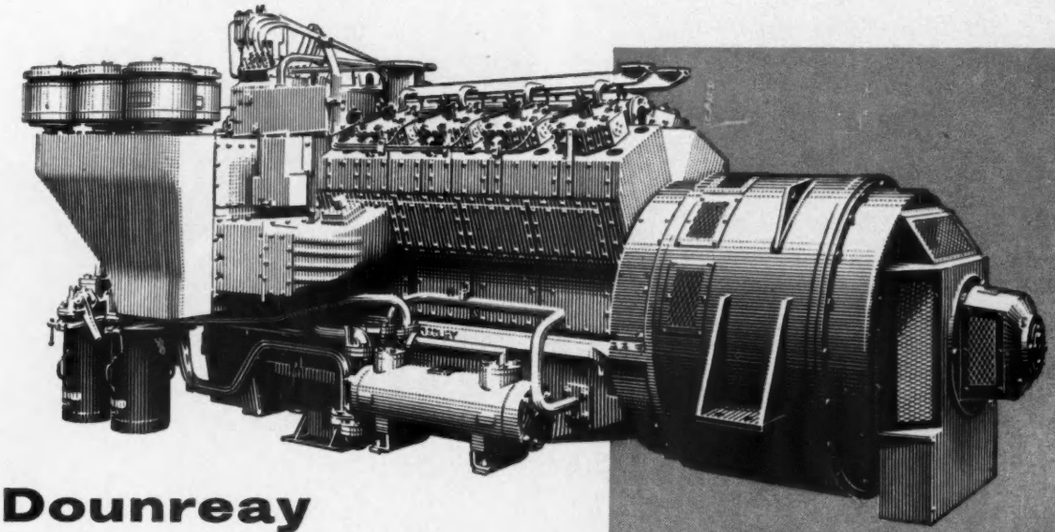
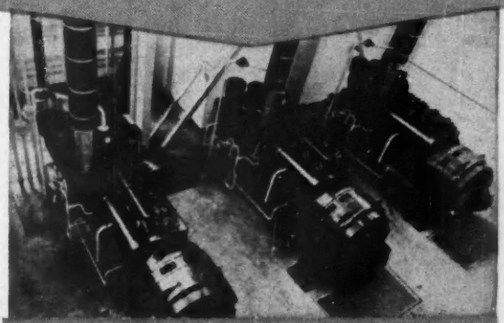


At Dounreay Crossley Diesels drive these



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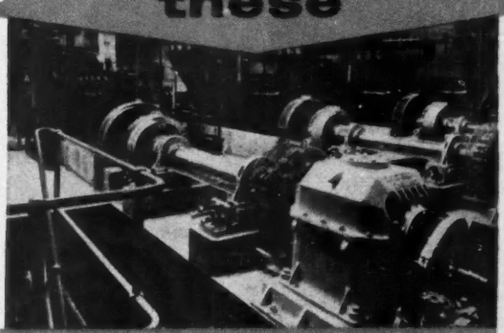

and these

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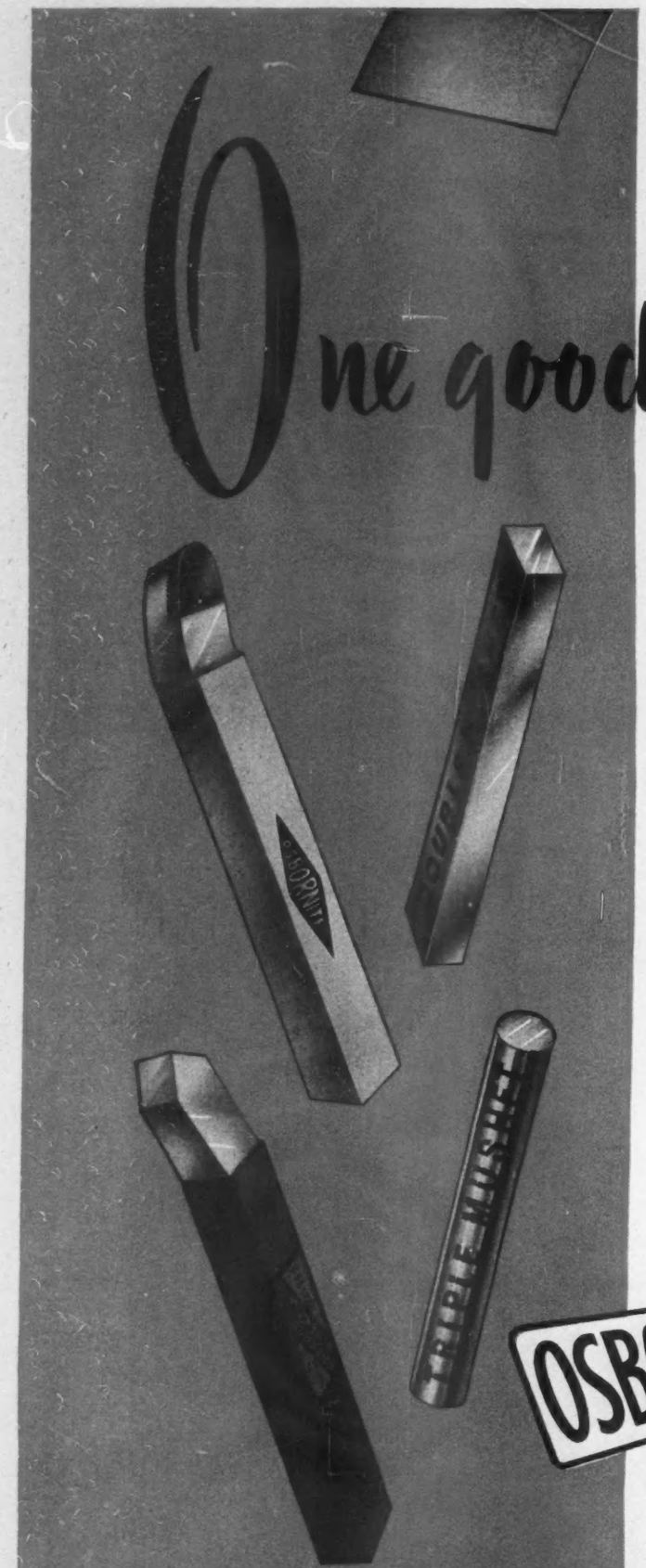

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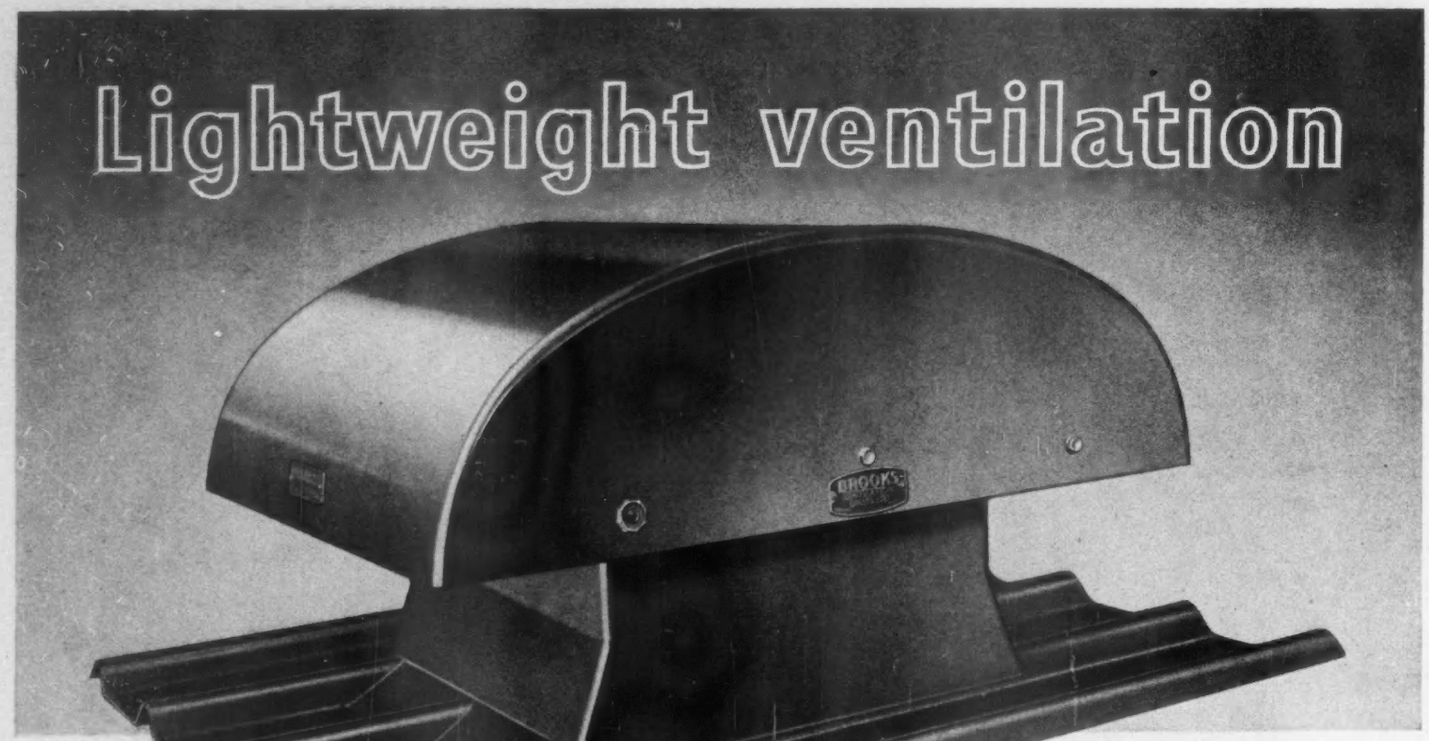

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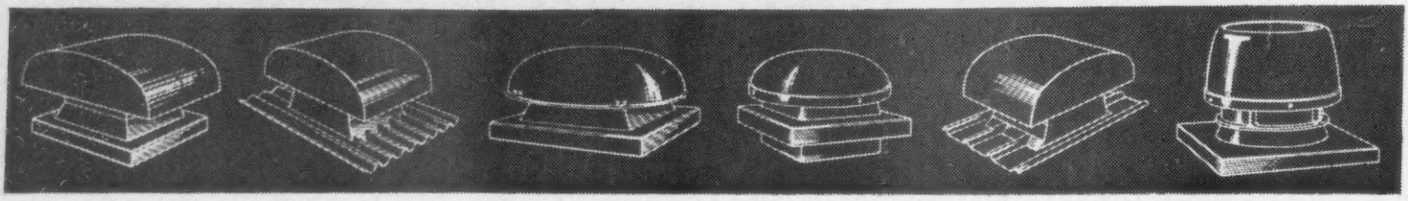

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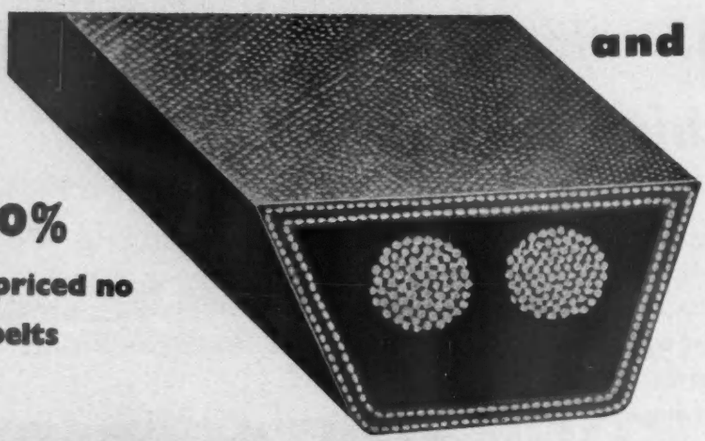

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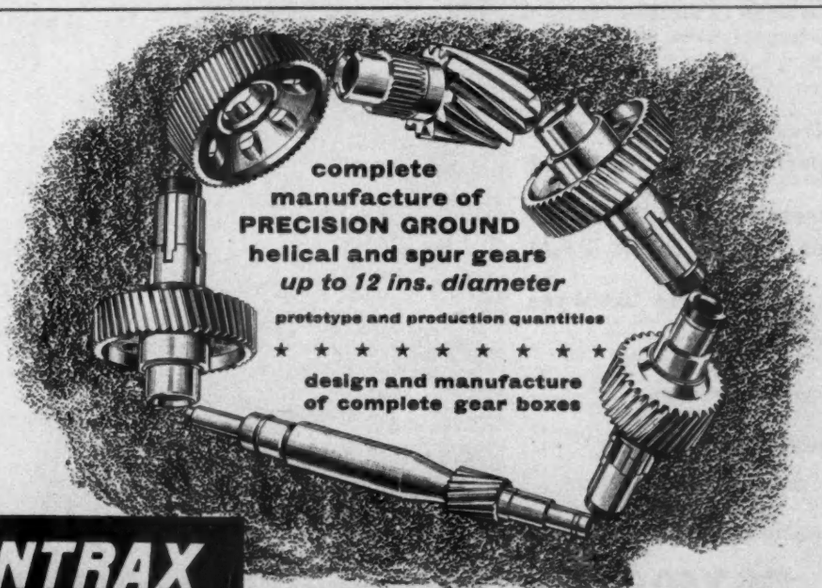

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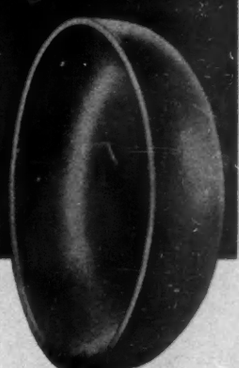

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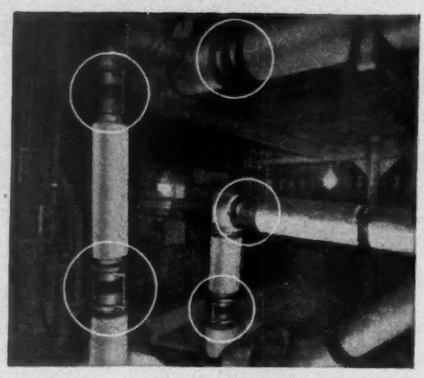

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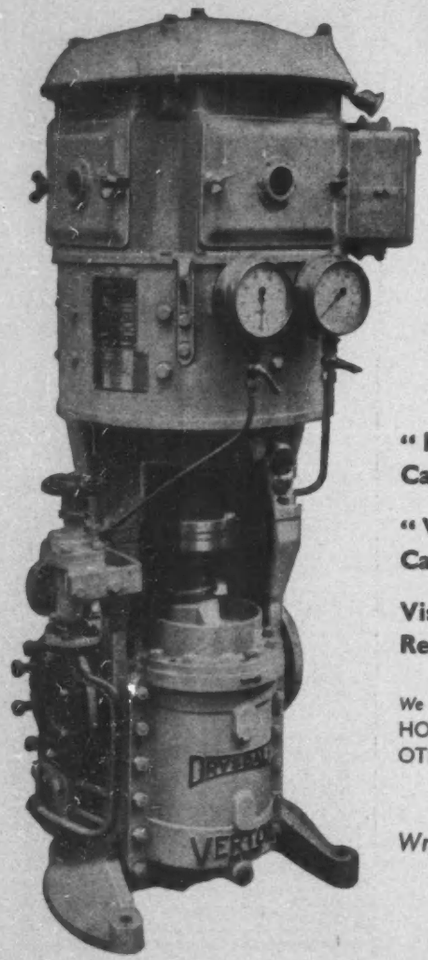

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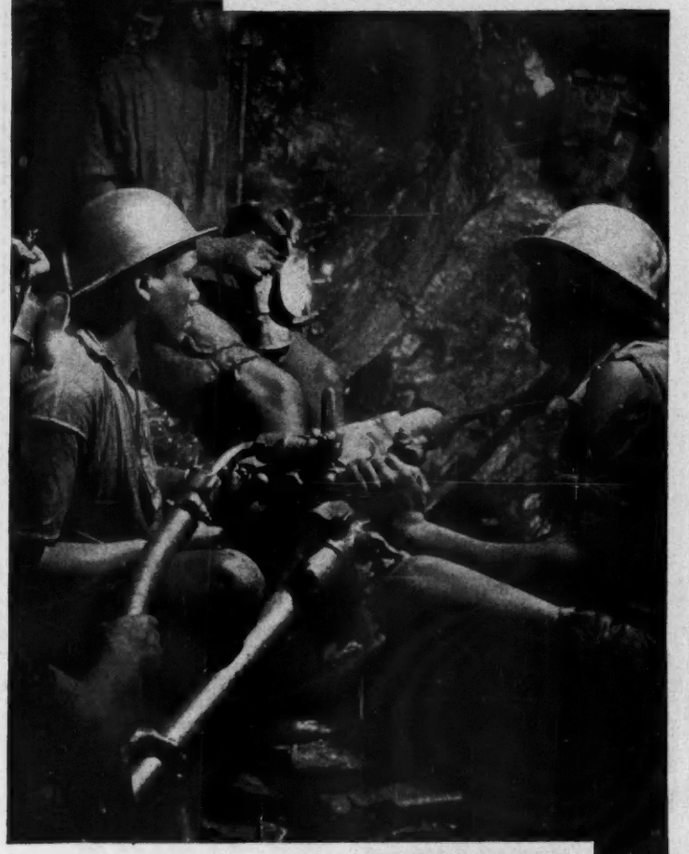

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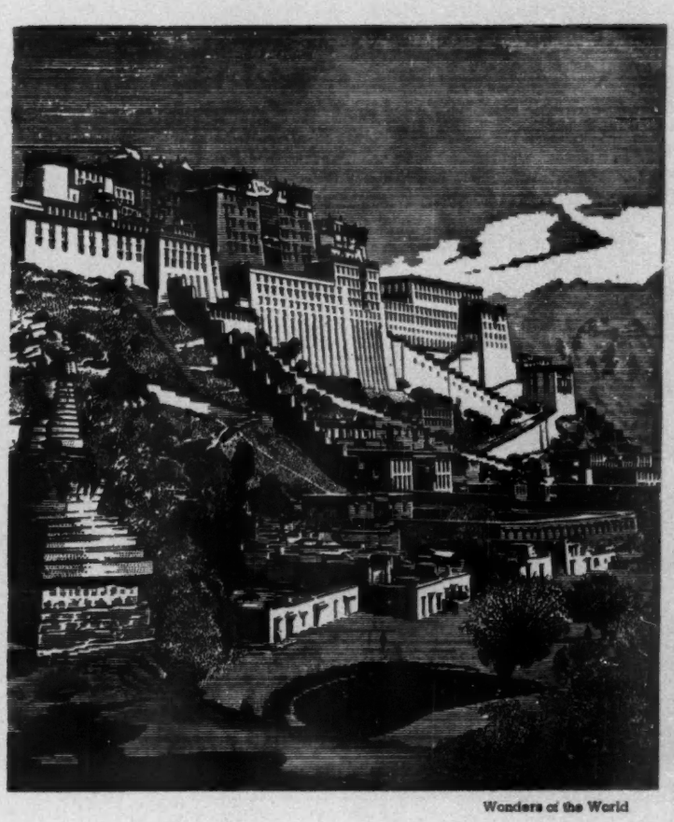

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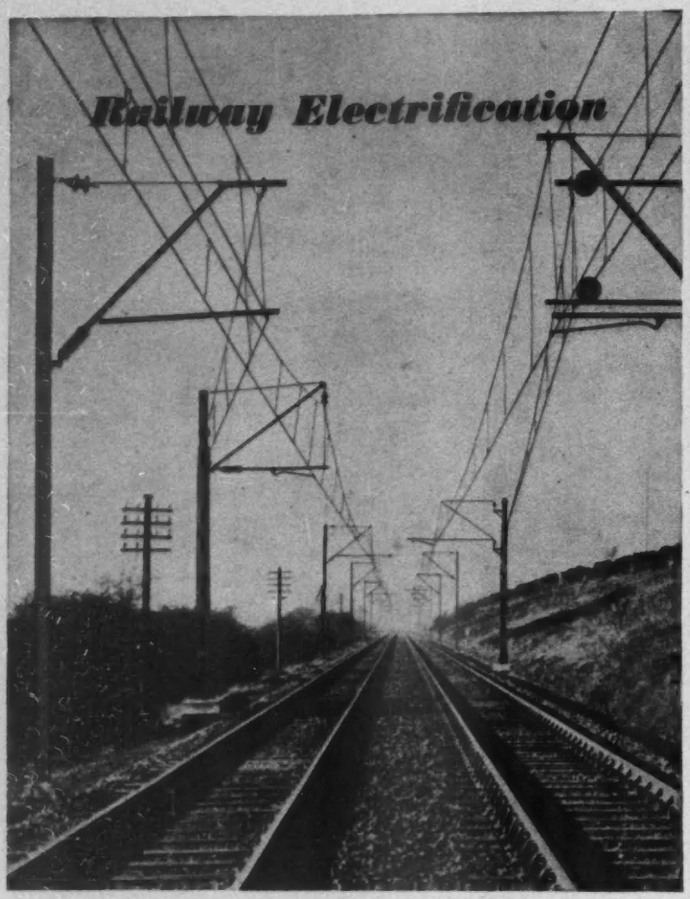

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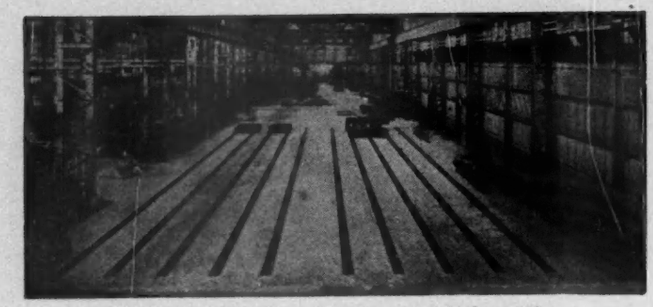

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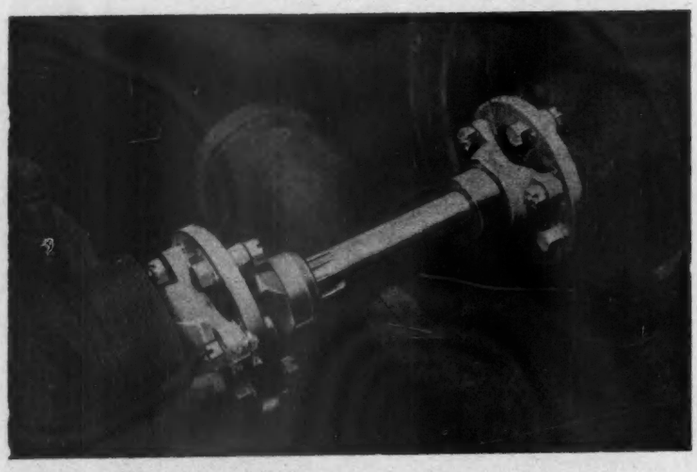

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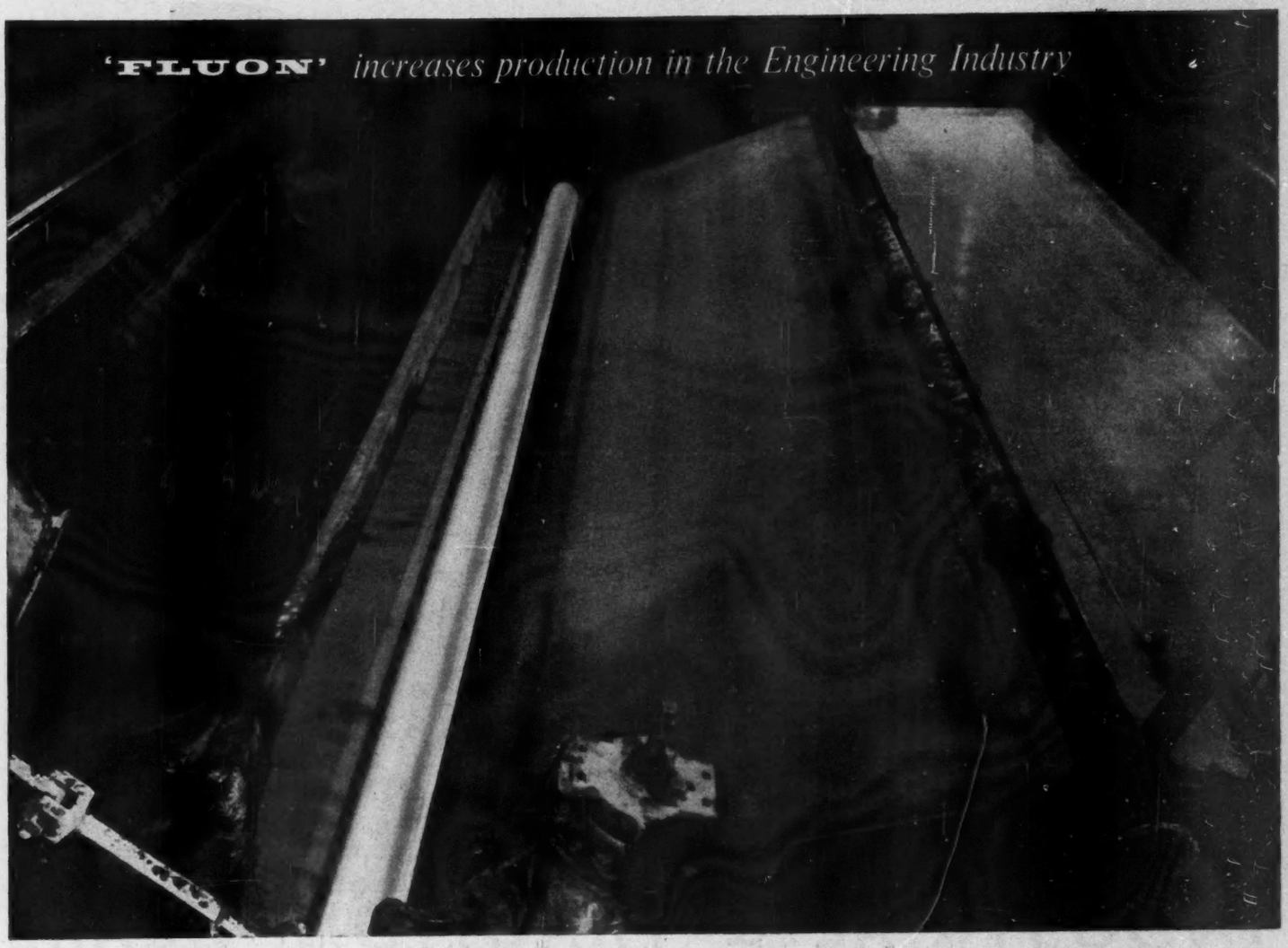

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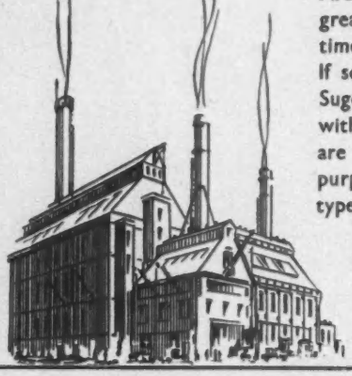

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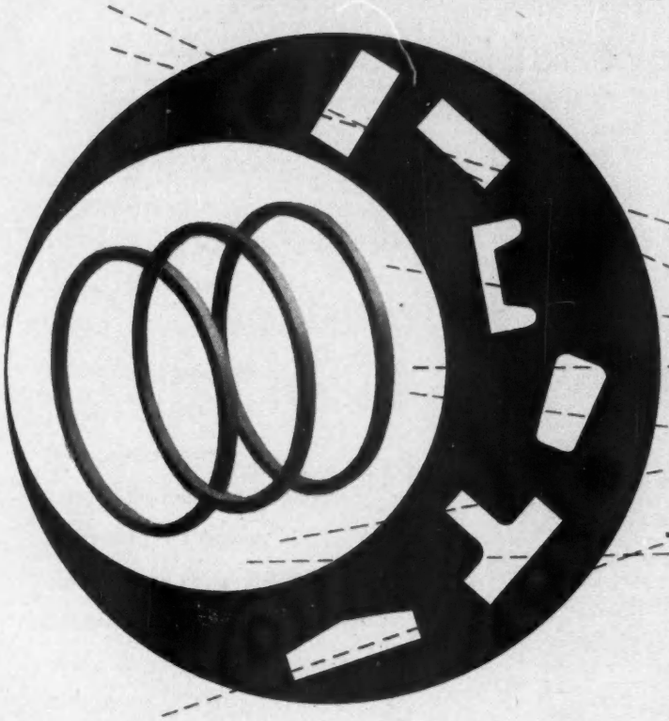

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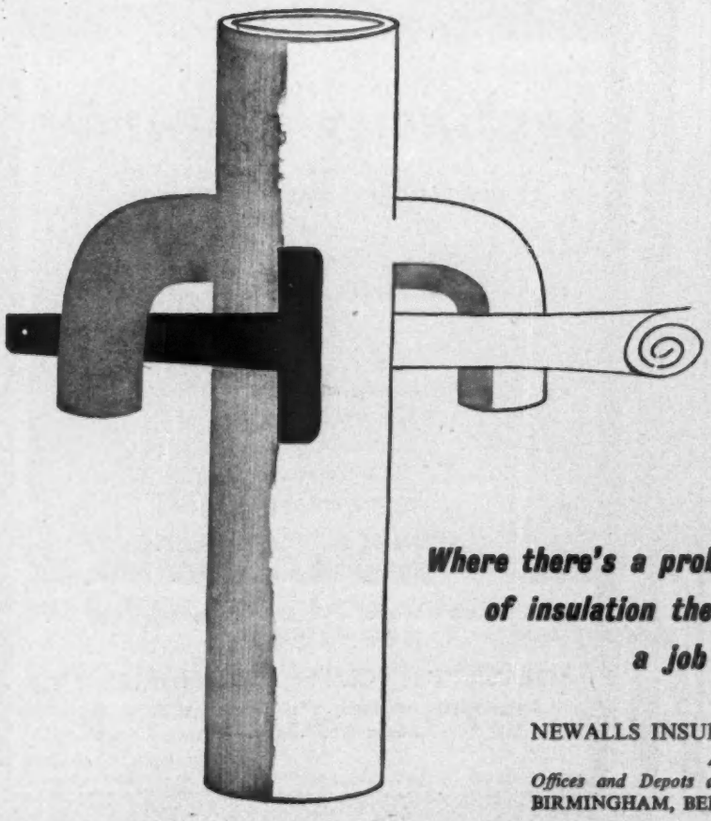

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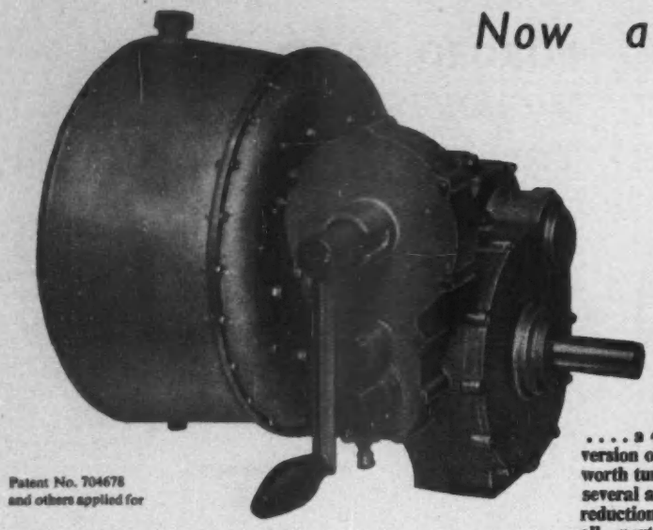

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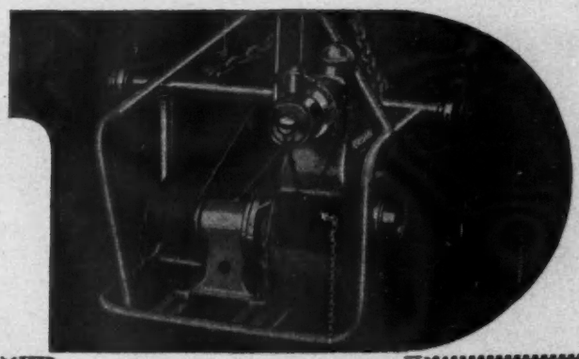

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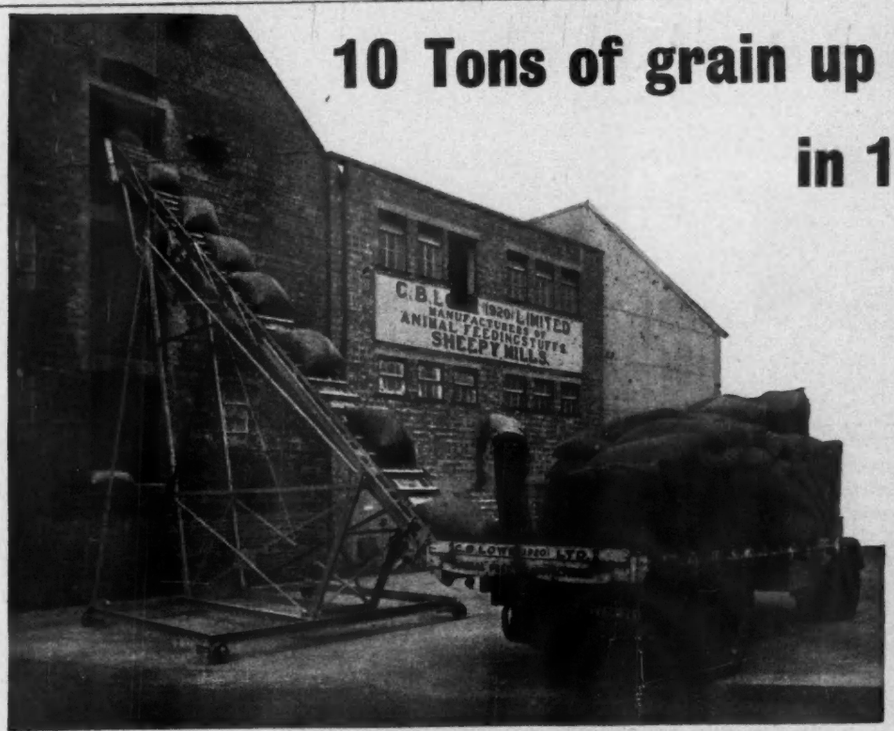

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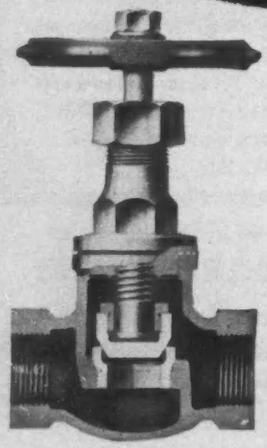

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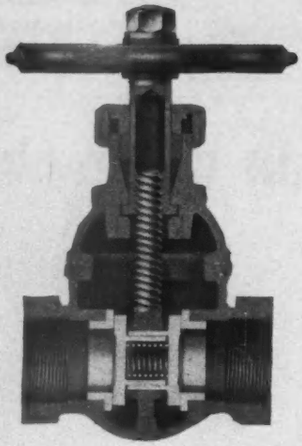

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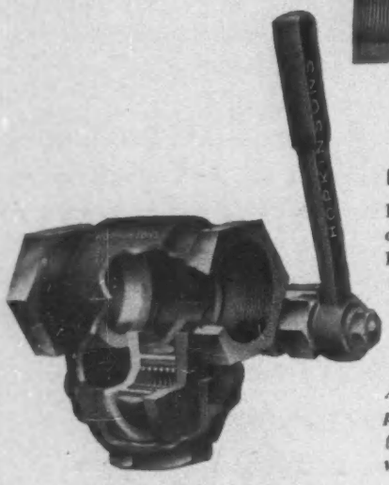

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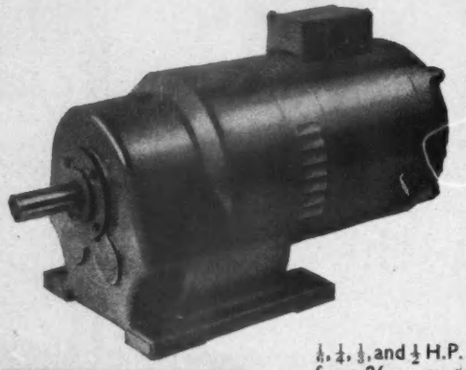

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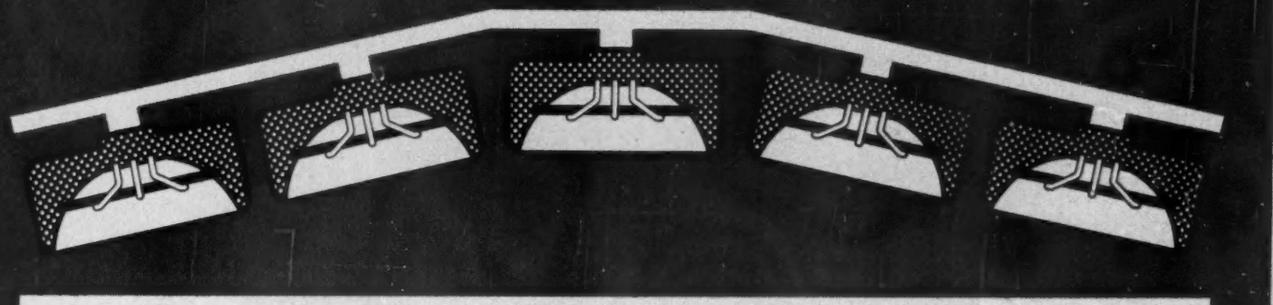

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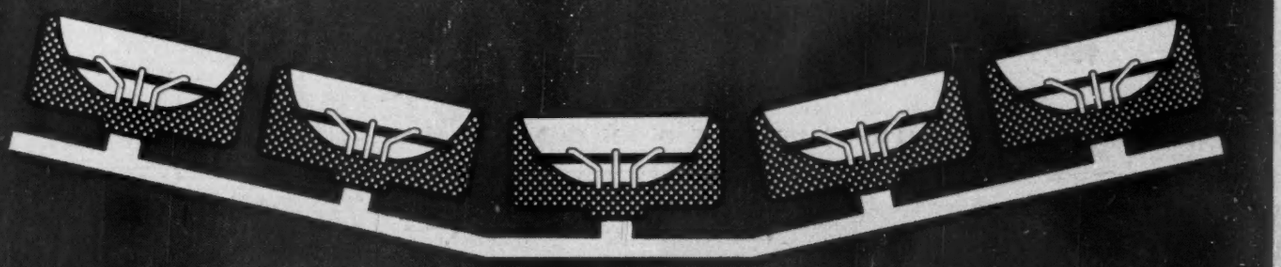

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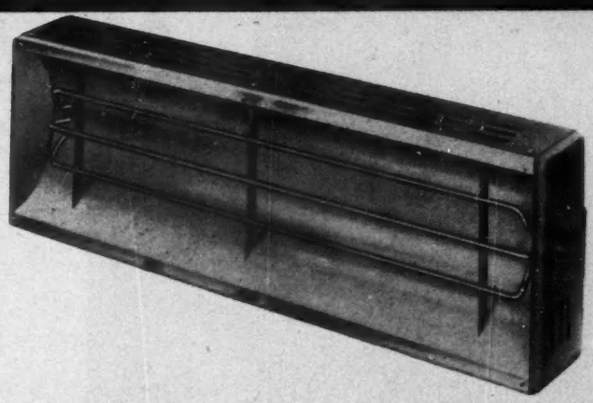

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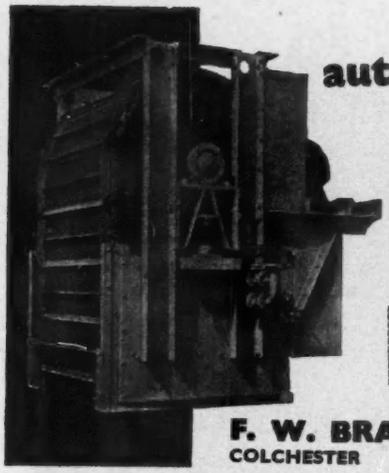

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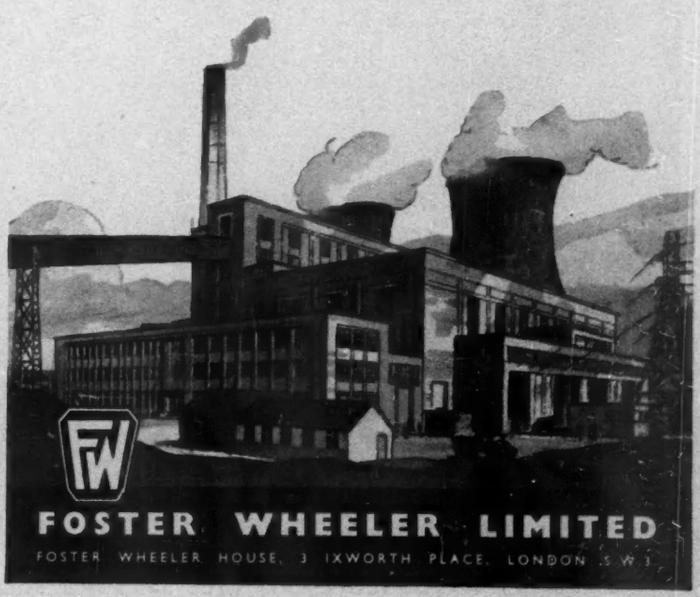

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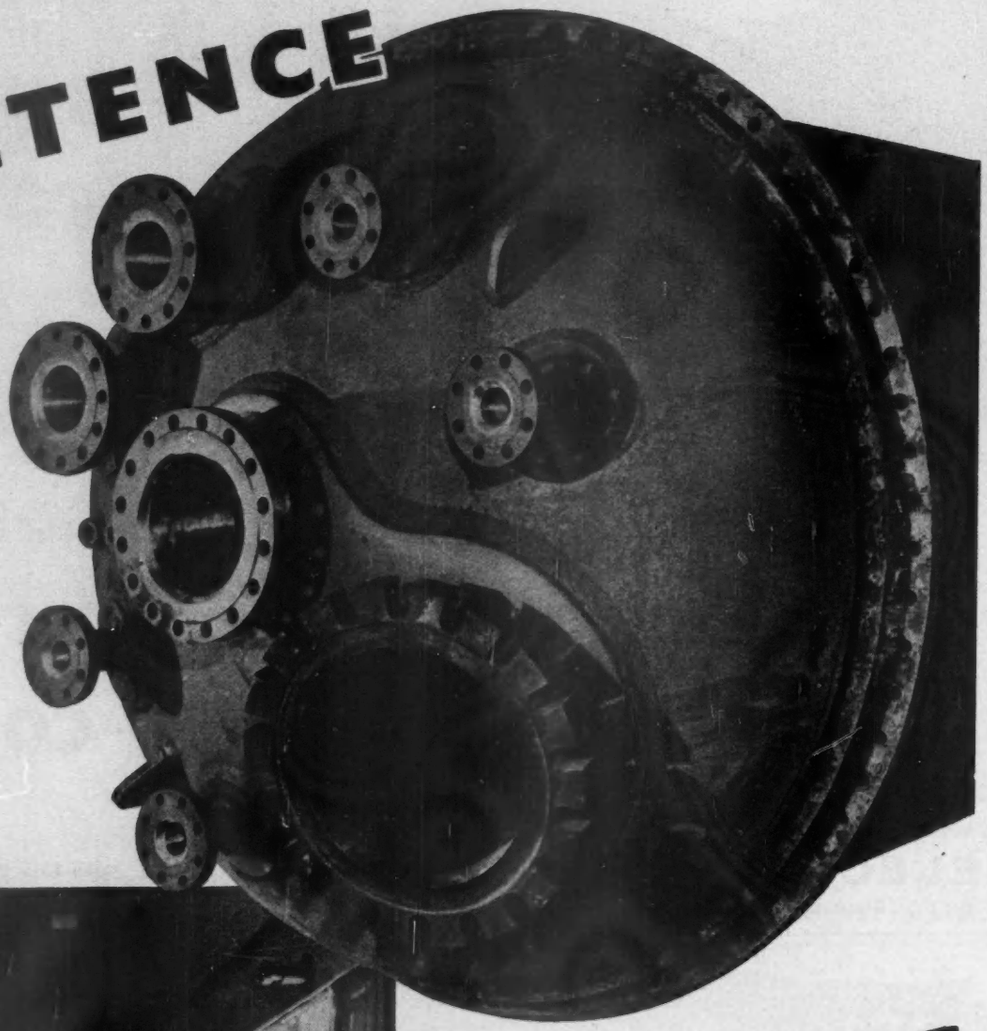

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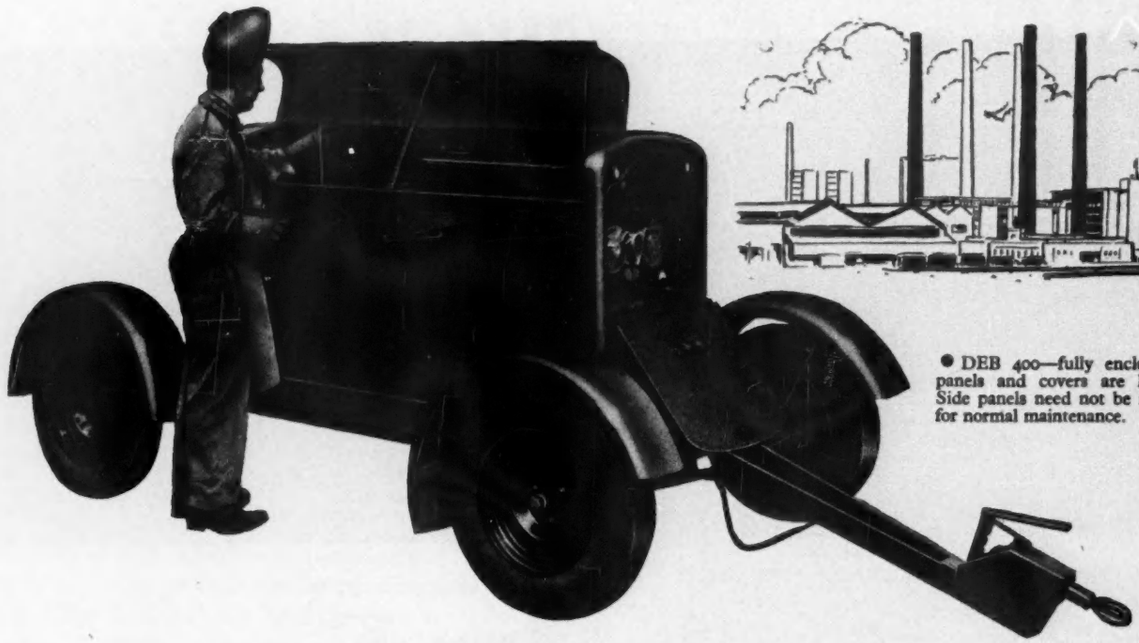

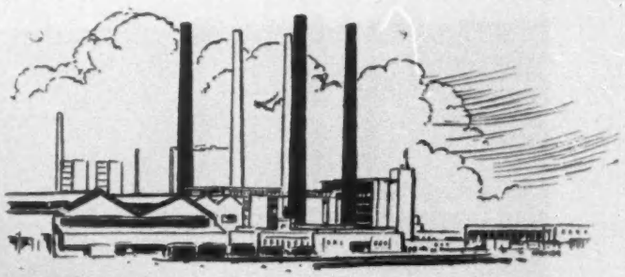

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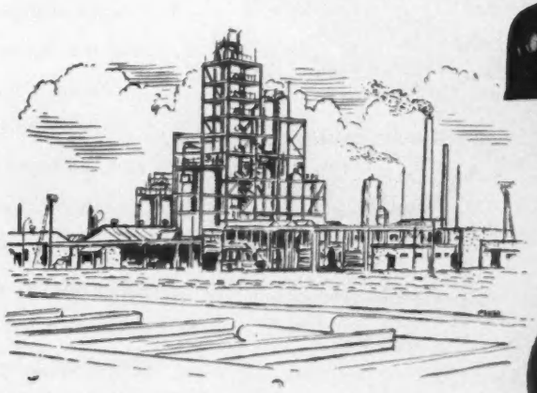

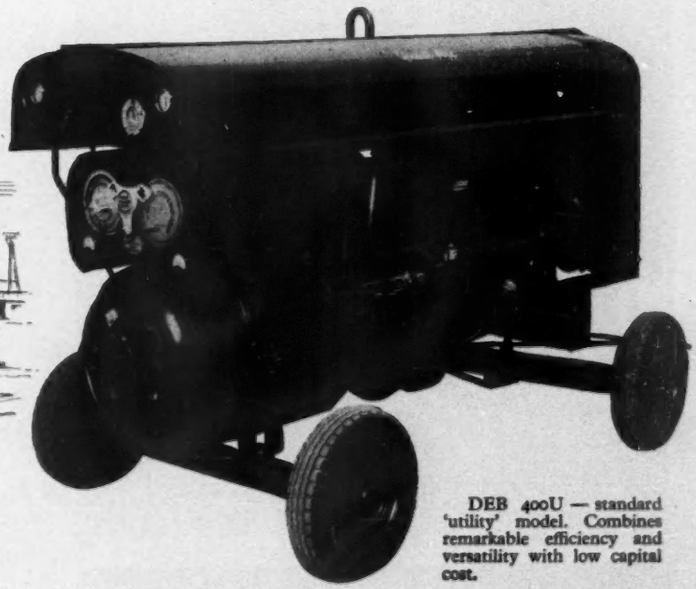

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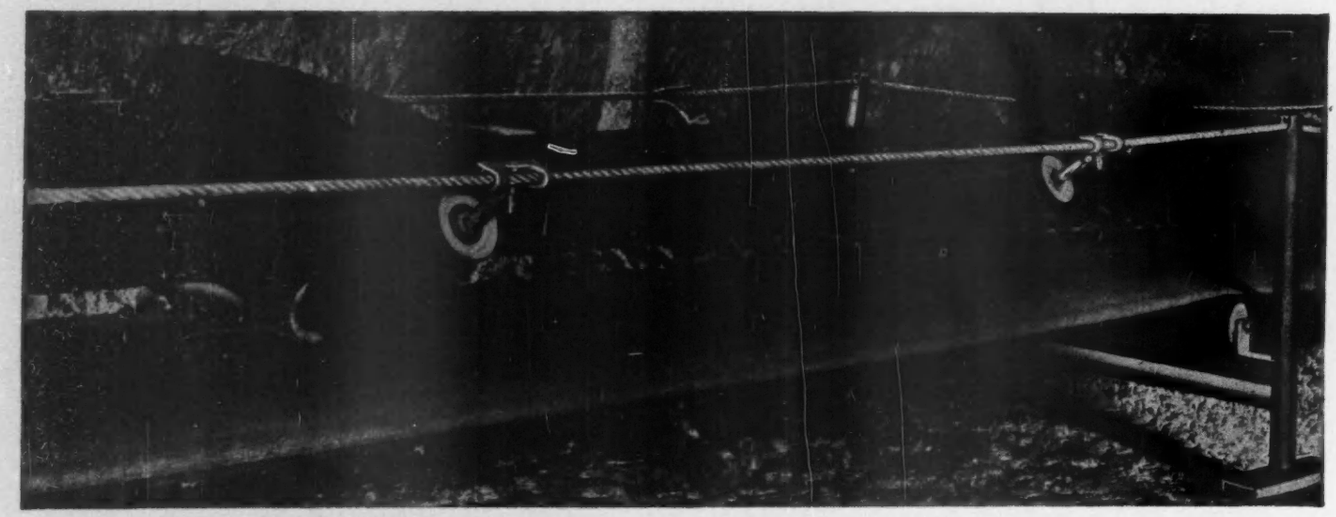

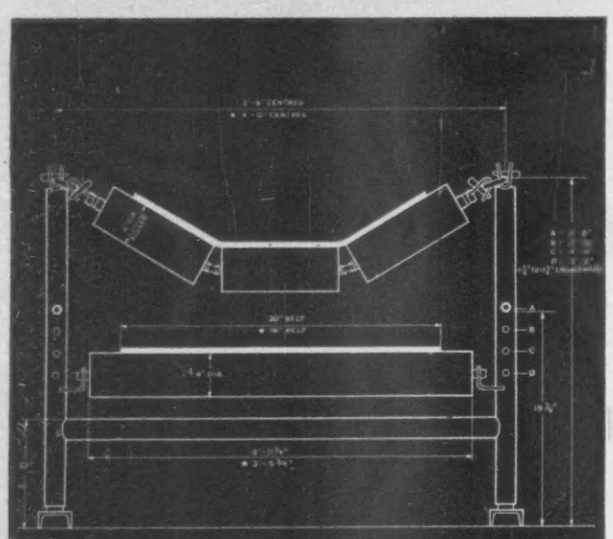

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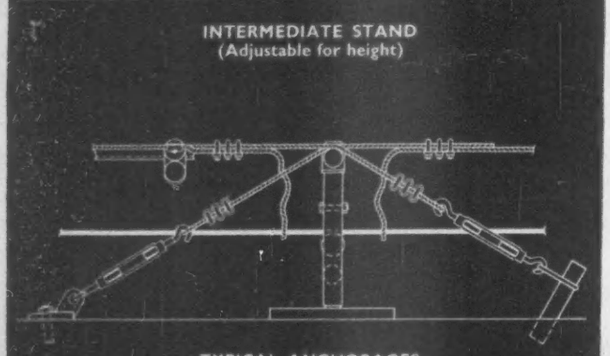

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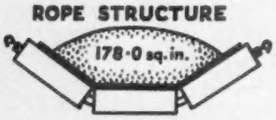

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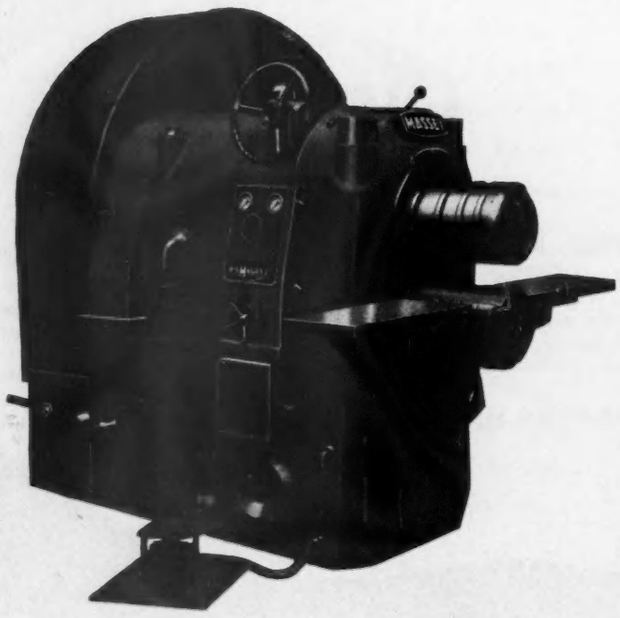

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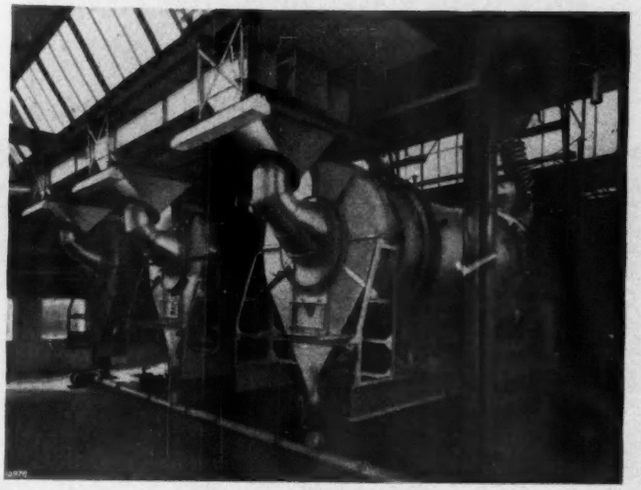

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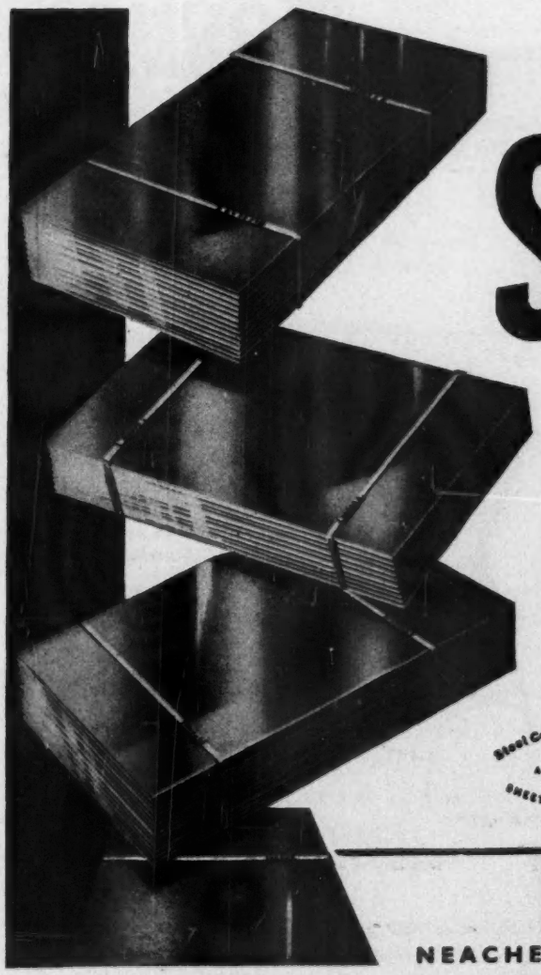

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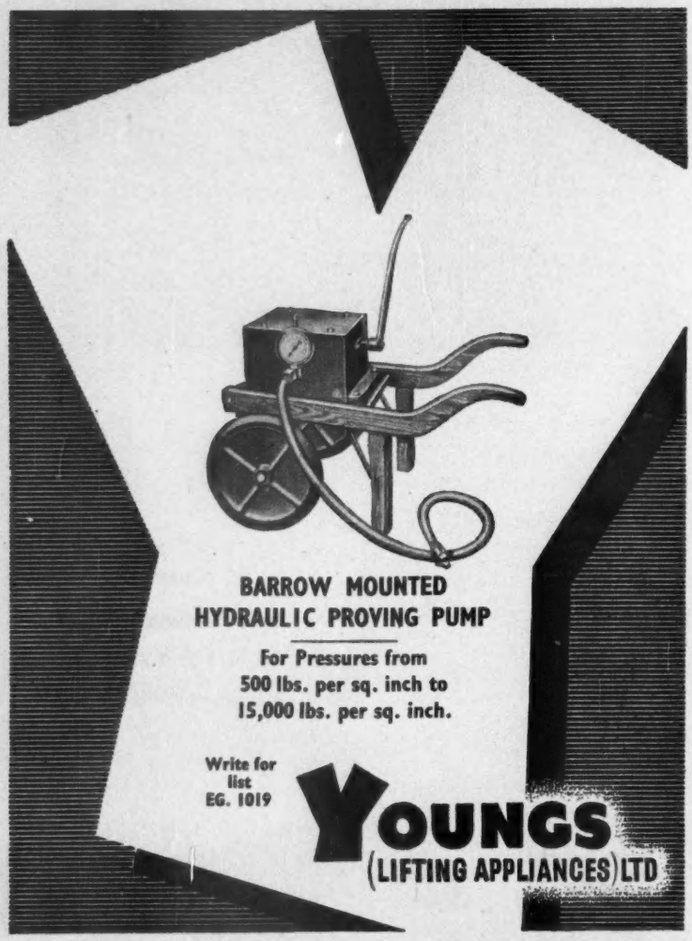

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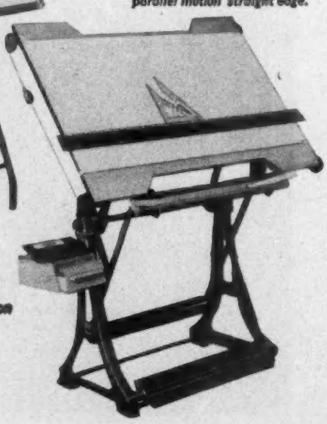

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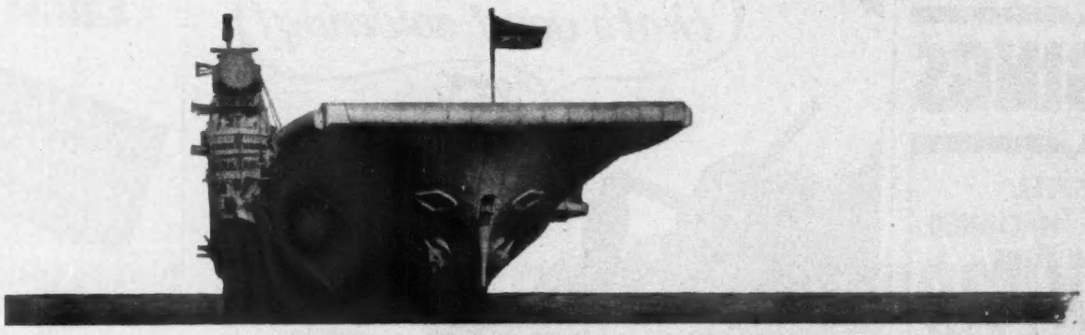

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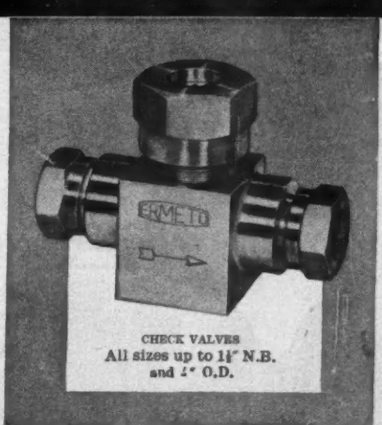

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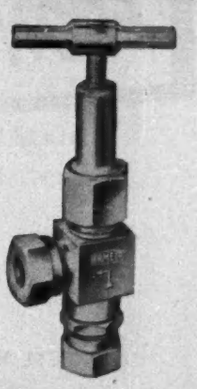

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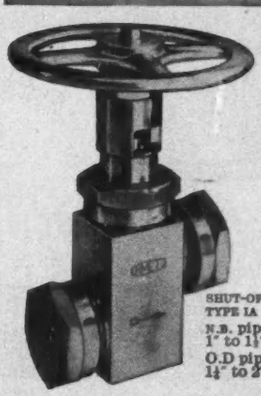

SHUT-OFF VALVES TYPE IA
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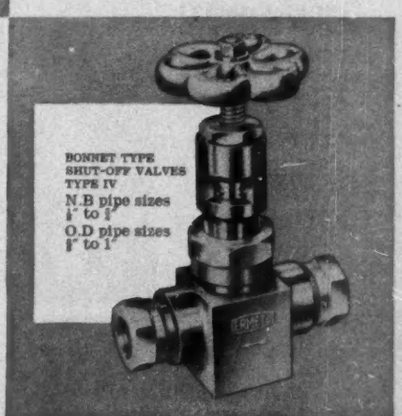
O.D pipe sizes 1¼" to 2"



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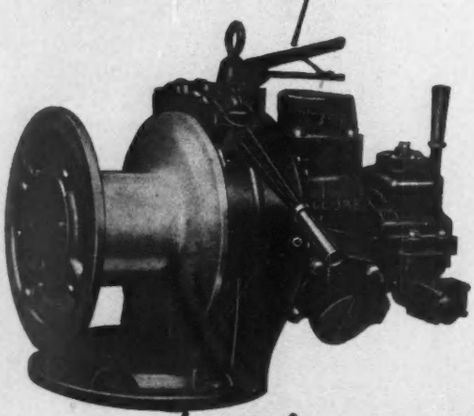

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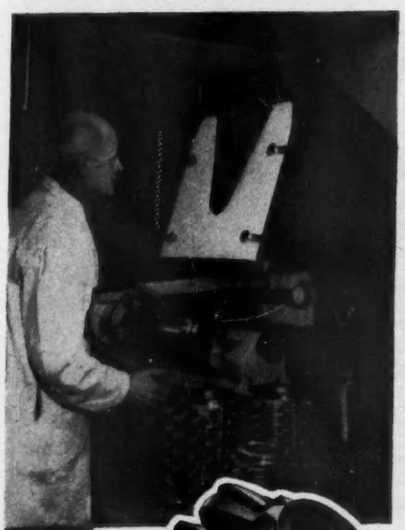

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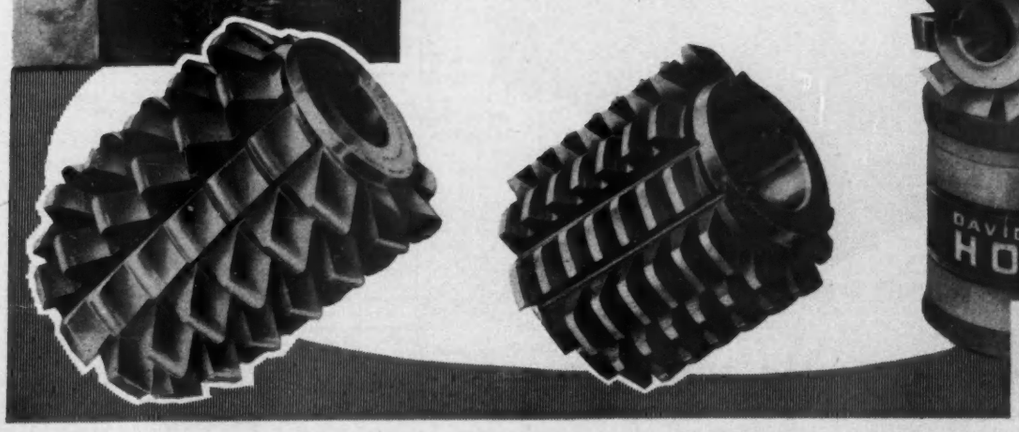

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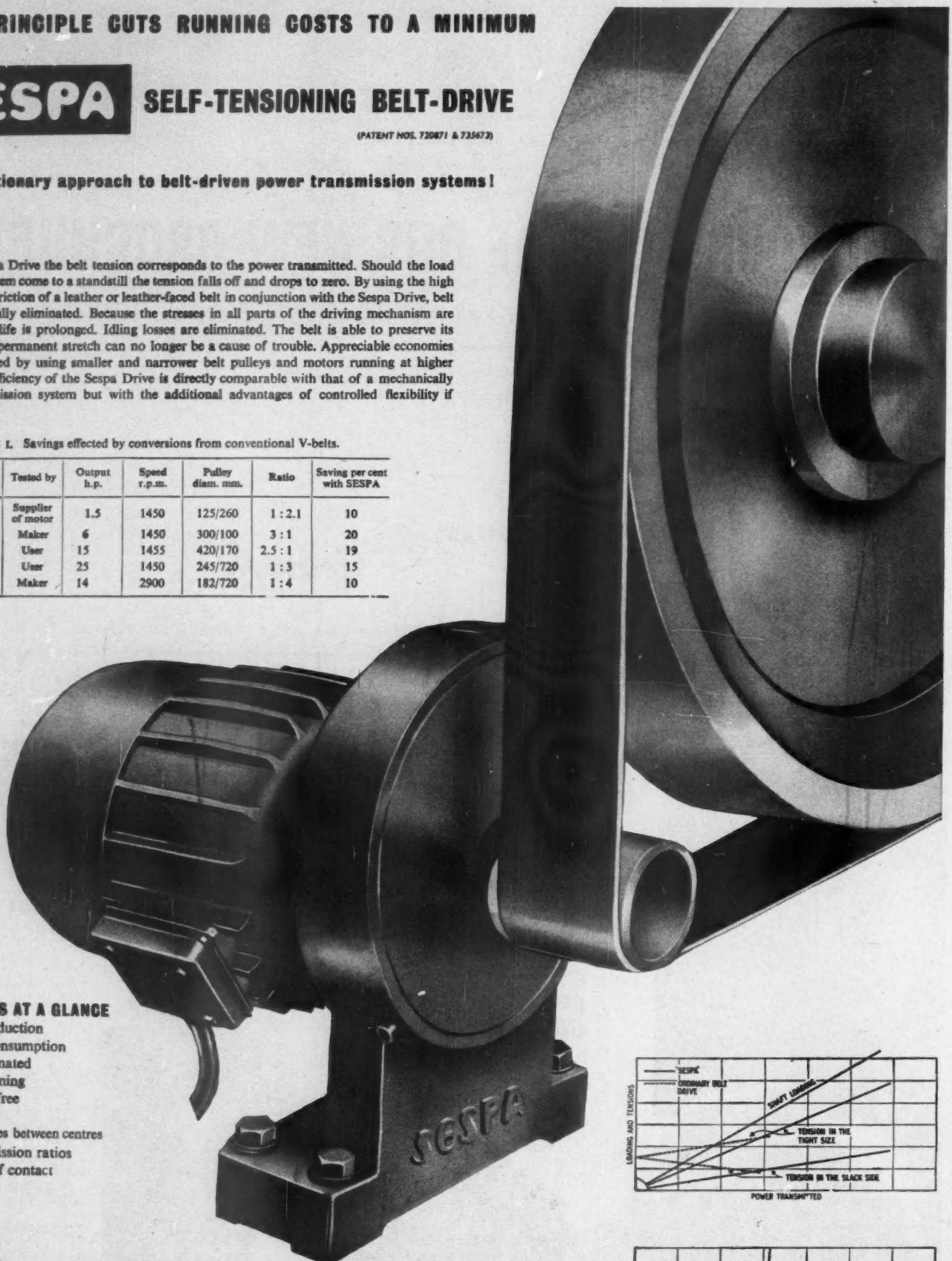
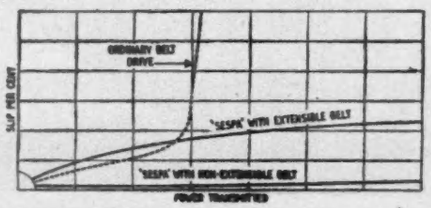
TABLE I. Savings effected by conversions from conventional V-belts.

Conditions Application	Tested by	Output h.p.	Speed r.p.m.	Pulley diam. mm.	Ratio	Saving per cent with SESPA
Loom	Supplier of motor	1.5	1450	125/260	1 : 2.1	10
Hammermill	Maker	6	1450	300/100	3 : 1	20
Fan	User	15	1455	420/170	2.5 : 1	19
Fan	User	25	1450	245/720	1 : 3	15
Compressor	Maker	14	2900	182/720	1 : 4	10



ADVANTAGES AT A GLANCE

Increased production
Less power consumption
Belt slip eliminated
Smoother running
Maintenance free
Reduced wear
Shorter distances between centres
Larger transmission ratios
Small angles of contact



SESPA can solve your most difficult problem of power transmission

WRITE NOW FOR FURTHER DETAILS TO

SESPA U.K. LIMITED, 243, Church Road, Mitcham, Surrey

Telephone: Mitcham 1802 Telegrams: Sespa, Mitcham

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.
Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch.
There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.
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Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-on and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.
Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.
Use of Box Number. 2/- which includes forwarding of replies.
Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**
Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

UNIVERSITY OF ABERDEEN AND ROBERT GORDON'S COLLEGES

UNIVERSITY LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the post of UNIVERSITY LECTURER IN MECHANICAL ENGINEERING. Candidates should preferably have qualifications in applied thermo-dynamics. An interest in Heat Transfer apparatus, or in the special problems associated with the generation of Heat and Power from Nuclear Reactors, and some industrial or research experience would be an advantage. There are excellent facilities for research or advanced studies requiring appreciable quantities of steam or compressed air.

The University Regulations permit members of the teaching staff to read for the degree of Ph.D. by research.

Salary in range rising to £1650, with membership of the F.S.S.U. and children's allowances. Initial Salary according to qualifications and experience. University owned accommodation becomes available from time to time.

Further information may be obtained from the Secretary, The University, Aberdeen, with whom applications (20 copies) giving names of three referees, should be lodged not later than 1st October, 1958. An applicant outside the British Isles may submit one copy of application. E8367

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

SHAKESPEARE STREET, NOTTINGHAM

Principal: D. A. R. CLARK, M.Sc. (Tech.), M.I.Mech.E.

RESEARCH ASSOCIATE IN MECHANICAL ENGINEERING

Applications are invited from Engineering Graduates for appointment to the post of RESEARCH ASSOCIATE IN MECHANICAL ENGINEERING. Previous research experience is desirable but not essential. The post offers considerable scope and encouragement will be given to obtain higher qualifications.

Salary: £650 by £50 to £750 per annum.

Further particulars and form of application may be obtained from the Principal, to whom completed forms should be returned not later than 17th September, 1958. E8407

NEW ZEALAND EDUCATION DEPARTMENT

INSPECTOR OF TECHNICAL EDUCATION

The Government of New Zealand invites applications for the position of INSPECTOR OF TECHNICAL EDUCATION with Headquarters in Wellington or Auckland or Christchurch.

Salary range £1290 to £1640. Commencing salary will depend on experience and qualifications.

For further information, apply to:
The Official Secretary,
New Zealand House,
415, Strand, London, W.C.2.
Completed applications to be lodged in London not later than 20 September, 1958. E8427

CIVIL SERVICE COMMISSION

H.M. DOCKYARD TECHNICAL COLLEGES

TEACHING POSTS

Five pensionable (non-contributory) ASSISTANT LECTURER posts for men: at Portsmouth for Mechanical or Electrical Engineering: at Devonport for English with a modern language: at Chatham one for Mathematics and Science, another for Naval Architecture: at Rosyth for English and Mathematics. Ability to help with other subjects essential. Qualifications: University degree or equivalent and ability to teach special subject to H.N.C. standard. Burnham scales for Technical Colleges.—Write Civil Service Commission, Burlington Gardens, London, W.1, for application form, quoting 4883/58. Closing date 8th September, 1958. E8406

PUBLIC APPOINTMENTS

COUNCIL FOR TECHNICAL CO-OPERATION IN SOUTH AND SOUTH-EAST ASIA

UNIVERSITY OF RANGOON, BURMA

LECTURER

Applications are invited by the Foreign Office for an appointment as LECTURER IN MECHANICAL ENGINEERING at the University of Rangoon, Burma, under the Technical Corporation Scheme of the Colombo Plan. Should preferably hold a higher degree with, in addition, at least 3 years' practical experience.

Will be required to teach up to degree level. Duration 2 years. Contract with the U.K. Government. Salary £1650 per annum (subject to U.K. income tax), plus tax-free overseas allowance of £1360 p.a. for married man (less for a single man) plus other allowances. Free furnished accommodation provided. For further information and application form write Ministry of Labour and National Service (E.9), 26–28, King Street, London, S.W.1, quoting E9/TCS/234/BUR. E8368

SOUTH-EAST ESSEX TECHNICAL COLLEGE,

LONGBRIDGE ROAD, DAGENHAM

HEAD OF THE MECHANICAL AND PRODUCTION ENGINEERING DEPARTMENT (GRADE V)

Applications are invited for the post of HEAD OF THE MECHANICAL AND PRODUCTION ENGINEERING DEPARTMENT (Grade V). Candidates should have high academic qualifications together with teaching and industrial experience. The appointment will date from 1st January, 1959, or earlier if possible. Salary: £1900 by £50 to £2050 plus London Allowance.

Application received in response to the earlier advertisement will be considered without further request.

Application forms and further details (stamped addressed foolscap envelope) obtainable from the Chief Education Officer, County Offices, Chelmsford. Closing date, 10th September, 1958. E8437

HAILSHAM HOSPITAL MANAGEMENT COMMITTEE

HELLINGLY HOSPITAL

SENIOR ENGINEER

SENIOR ENGINEER required for Hellingly Hospital. Successful applicant will be responsible to the Superintendent Engineer and should have a good knowledge of engineering and building construction. Good house available at moderate rent. Salary £740 by £25 (2) by £30 (3) to £880 per annum.—Applications, stating age, experience, &c., and the names of two referees, to the Secretary, Hailsham Hospital Management Committee, Hellingly Hospital, Hailsham, Sussex, within ten days of the appearance of this advertisement. E8438

NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD

ELECTRICAL AND MECHANICAL ENGINEERING DEPARTMENT

ASSISTANT ENGINEER

Applications are invited for the post of ASSISTANT ENGINEER in the Electrical and Mechanical Engineering Department of the Board's Head Office in Edinburgh. Applicants should have a sound technical education and be capable of dealing with matters of technical design and investigation and generating station planning and operation. Salary commencing at a point within the range £1055–£1250 (N.J.B. Schedule B, Class AX/CX, Grade 5), depending on experience and qualifications. Superannuation scheme.

Application form, obtainable from the Secretary, 16, Rothesay Terrace, Edinburgh, 3, should be returned within 21 days from the date of this advertisement. E8435

PUBLIC APPOINTMENTS

NORTHERN IRELAND HOSPITALS AUTHORITY

TYRONE AND FERMANAGH HOSPITAL MANAGEMENT COMMITTEE

TYRONE AND FERMANAGH HOSPITAL, OMAGH

SUPERINTENDENT ENGINEER

Applications are invited from suitably qualified persons for the above post.

Tyrone and Fermanagh Hospital is a mental hospital of 1150 beds. In addition to the duties which would normally attach to the post of SUPERINTENDENT ENGINEER, the officer appointed will be responsible for the general supervision of maintenance and engineering works in two other hospital groups in the area, comprising seven hospitals.

Qualifications: The person appointed must have had a thorough practical engineering training and have a sound knowledge of steam boiler plant operation and such mechanical and electrical services as are found in hospitals. He must also have a sound knowledge of sanitation codes, water supply systems and maintenance of fabric of buildings. He must have passed an examination in Engineering Technology and hold a recognised engineering qualification to the standard of—

First Class Certificate of Competency in Marine Engineering or equivalent Naval Service; or City and Guilds Full Technological Certificate in Plant Engineering (First Class) (from 1957); or an equivalent qualification approved by the Authority.

Salary: The salary attaching to the post will be £980 p.a. by £30 (4) by £35 (1) to £1135 p.a. subject to superannuation deductions in accordance with the Health Services (Superannuation) Regulations (Northern Ireland).

The person appointed will be an officer of the Northern Ireland Hospitals Authority and the Authority's general conditions of service will apply to the post.

Applications giving full details of qualifications, training, experience, etc., accompanied by two recent testimonials and the names of two referees from whom confidential reports may be requested, should be sent to the Secretary, Tyrone and Fermanagh Hospital, Omagh, Co. Tyrone, so as to arrive before the 30th September, 1958.

Canvassing disqualifies. Preference given to candidates who have served in H.M. Forces in wartime. E8409

LIVERPOOL REGIONAL HOSPITAL BOARD

ASSISTANT ENGINEER

ASSISTANT ENGINEER (MECHANICAL) required on the staff of the Regional Engineer.

Applicants should have passed the Institution examination and be Graduate Members of the Institution of Mechanical Engineers or Corporate Members of the Institution of Heating and Ventilating Engineers, and should preferably have had experience in the design, drawing up of plans and specifications for engineering equipment for hospitals, particularly heating, domestic hot water and ventilating schemes, be able to prepare complete working drawings from rough sketches and take the necessary particulars on site for complete engineering schemes. The successful applicant will take charge of the drawing-office.

Salary scale: £700–£1015 per annum.

Starting salary dependent on age and previous relevant practical experience.

Applications, stating age, qualifications, experience, present and previous posts, with names and addresses of three referees (2 technical), to reach me at 55, Castle Street, Liverpool, 2, by 8th September, 1958.

VINCENT COLLINGE,
E8337 Secretary to the Board.

MINISTRY OF FINANCE

HEATING AND VENTILATING ENGINEER

Applications invited from Corporate Members of the Institution of Mechanical Engineers for unestablished post in Ministry of Finance. Experience essential in preparation of designs and specifications and installation of heating, plumbing and steam services for commercial and industrial buildings. Salary £780 (age 25)—£1055 (age 34 and over)—£1215. Preference for ex-Servicemen.—Application forms obtainable from Director of Establishments, Room 271, Stormont, Belfast, to be returned by 26th September, 1958. E8408

PUBLIC APPOINTMENTS

SKEGNESS URBAN DISTRICT COUNCIL

WATER ENGINEER'S DEPARTMENT

APPOINTMENT OF RESIDENT PUMPING STATION ENGINEER

Applications are invited for the post of RESIDENT PUMPING STATION ENGINEER at the Council's Waterworks Pumping Station at Welton-le-Marsh, Spilsby, Lincs. The post is an established one on the Council's permanent staff and the salary payable is in accordance with A.P.T. Division II of the National Salary Scales (£725, rising by annual increments of £30 to £845 per annum).

The duties entail the responsibility, under the Council's Water Engineer, for the operation, repair and maintenance of the diesel and electric pumping plant, boreholes, machinery, &c., and covered reservoirs at Welton, Candleshy, Orby and Skegness, together with the control of pumping station personnel (at present 3 men).

Applicants should have had experience in a similar capacity, have completed training with an approved engineering firm and have workshop experience.

The appointment will be subject to the National Scheme of Conditions of Service, the Local Government Superannuation Acts, and to the passing of a medical examination.

The person appointed will be required to reside, on a service tenancy, in the house provided at the Welton Waterworks, for which a deduction of £52 per annum will be made from the salary offered in respect of rent, rates, light, water and fuel, and he will be expected to put in such hours of duty as required to maintain the water supply to the town.

Applications, stating age, qualifications, details of present and previous appointments and experience, and giving the names of two referees, should be forwarded to the undersigned by Monday, September 8, 1958. Applicants should state whether or not they are related to any member or senior officer of the Council.

MILTON TURNER,
Clerk of the Council.

Town Hall,
Skegness, Lincs.
20th August, 1958. E8436

MERSEY DOCKS AND HARBOUR BOARD

JUNIOR ASSISTANT SUPERINTENDENT ENGINEER

Applications are invited for a JUNIOR ASSISTANT SUPERINTENDENT ENGINEER of their Dredgers, Hoppers, Floating Cranes, Pilot Boats, &c.

An Extra First Class Ministry of Transport Certificate and experience of ship repair work and diesel engines will be an advantage.

Salary: £1100 per annum—age between 30 and 40 years.

Applications should be addressed to the Engineer-in-Chief, Mersey Docks and Harbour Board, and received not later than the 8th September, 1958.

A. S. MOUNTFIELD,
General Manager and Secretary.

Dock Office,
Liverpool, 3. E8386

NATIONAL COAL BOARD

DURHAM DIVISION

SENIOR CIVIL ENGINEER

Required for the Divisional Production Department in Newcastle upon Tyne.

Salary range: £1250–£1850.

The successful candidate will be required to assist the Divisional Civil Engineer with the general administration of a design and detailing office and to deal with Contractors for major Reconstruction Schemes.

Applicants should be fully qualified civil engineers with at least 12 years' post-graduate experience of heavy industrial civil engineering design and construction. They must have had wide experience of design and estimating work and varied site experience, preferably as a Resident Engineer.

Apply, within 7 days, quoting SG/128/5(78) and giving details of age, education, qualifications and experience, to Divisional Chief Staff Officer, National Coal Board, Durham Division, 7 Side, Newcastle upon Tyne, 1. E8381

Classified Advts. continued on page 90

PUBLIC APPOINTMENTS

STATE ELECTRICITY COMMISSION OF VICTORIA

AUSTRALIA

BRIQUETTE PRODUCTION STAFF

The State Electricity Commission of Victoria, Australia, seeks application from engineers with the required qualifications and experience for appointment to senior positions at its new Briquette Production Works at Morwell, in the Latrobe Valley, in Eastern Victoria, approximately 90 miles from Melbourne.

The Commission, constituted as a semi-government authority by Act of Parliament, is one of the largest electricity supply authorities in the Commonwealth of Australia and the largest producer of fuel, with brown coal and briquette enterprises in the Latrobe Valley. It has a capital investment of approximately £A250 million, with an annual revenue of £A36 million.

The briquette works at present operated by the Commission are situated at Yallourn, approximately six miles from Morwell, where over 600,000 tons of brown coal briquettes are produced each year. To satisfy the State's ever-increasing demand, the Commission is now developing, at Morwell, its second brown coal power and fuel project. This will comprise a major brown coal open cut and a large new power station, which will operate in association with large modern briquetting works. The new briquetting works will supply briquette fuel for power stations in Melbourne and provincial cities and a large proportion of Victoria's solid fuel requirements for industrial and domestic use. The Morwell Project is due to begin generating electricity and producing briquettes during 1959, and it is expected that, by 1961, the production of briquettes will be at the rate of 1,500,000 tons a year.

Facilities in this rapidly developing area include excellent schooling, shopping and sporting facilities, subsidised medical and hospital services, and the other modern amenities of urban areas.

The positions for which applications are invited are as follows :—

BRIQUETTE PRODUCTION SUPERINTENDENT
Salary up to £A2665 per annum.

Applicants, preferably, should possess a University Degree or Higher National Certificate in Mechanical Engineering or be Chartered Engineers, or possess equivalent qualification, and must have had extensive practical experience in the operation and maintenance of heavy industrial processing plant. Administrative ability in production control and the direction of personnel is essential.

Consideration will be given to applicants who possess a First Class M.O.T. or B.O.T. Certificate of Competency, provided details of practical experience are satisfactory.

A knowledge of the details of the brown coal briquetting process is desirable.

The appointee will be responsible for all the administrative aspects concerned with the production of briquettes and the direction of all personnel engaged in the operation and maintenance of plant and equipment at the Morwell Briquette Works.

ASSISTANT BRIQUETTE PRODUCTION SUPERINTENDENT
Salary up to £A2465 per annum.

Applicants, preferably, should possess a University Degree or Higher National Certificate in Mechanical Engineering, or be Chartered Engineers, or possess equivalent qualification, and must have had extensive practical experience in the operation and maintenance of heavy industrial processing plant. Administrative ability in production control and the direction of personnel is essential.

Consideration will be given to applicants who possess a First Class M.O.T. or B.O.T. Certificate of Competency, provided details of practical experience are satisfactory.

A knowledge of the details of the brown coal briquetting process is desirable.

The appointee will be responsible, under the direction of the Briquette Production Superintendent, for the efficient operation and maintenance of all plant and equipment at the Briquette Works and for the effective disposition of personnel.

FACTORY OPERATIONS SUPERINTENDENT
Salary up to £A2265 per annum.

Applicants should possess a Higher National Certificate in Mechanical Engineering, or be Chartered Engineers, or possess a First Class M.O.T. or B.O.T. Certificate of Competency, and must have had extensive practical experience in the operation of heavy industrial processing plant. Ability to efficiently direct and control personnel is essential.

A knowledge of the details of the brown coal briquetting process and of rosters is desirable.

The appointee will be responsible, under the Assistant Briquette Production Superintendent, for the efficient operation of all mechanical production plant and will be required to supervise personnel engaged on operational duties. He will be responsible for the training and administration of the works fire-fighting services and may be required to be available for after-hours duty.

The cost of passages to Australia for appointees and their families will be borne by the State Electricity Commission and arranged by the Agent-General for Victoria, London.

Suitable houses for rental will be made available immediately to married appointees, and good hostel accommodation at a reasonable tariff will be available for single appointees.

Married appointees will be reimbursed, at the expiration of six months' satisfactory service, an amount of up to £A150 upon production of necessary receipts, in respect of removal of household furniture and effects.

Further details may be obtained on application to the Staff Superintendent at the address mentioned below.

Applications, giving full details of qualifications, experience and war service (if any), stating date of birth and accompanied by copies of testimonials, should be submitted, not later than 10th October, 1958, to the Secretary, State Electricity Commission of Victoria, 22–32, William Street, Melbourne, C.1, Victoria, Australia. E8333

PUBLIC APPOINTMENTS

FEDERATION OF MALAYA

CAMERON HIGHLANDS HYDRO-ELECTRIC SCHEME

CIVIL ENGINEERS

Applications are invited from CIVIL ENGINEERS for the following appointments, to supervise construction of a large hydro-electric scheme to be built by contract in the Cameron Highlands for the Central Electricity Board of the Federation of Malaya. The scheme includes 15 miles of tunnelling, a concrete dam and an underground power station for 100MW installation.

(a) CHIEF RESIDENT ENGINEER, to be the site representative of the Consulting Engineers. He will be responsible for the overall supervision of the construction and erection by contract of all civil, electrical and mechanical work, including transmission lines.
Applicants must be Members of the Institution of Civil Engineers, preferably aged between 45 and 55, and must have had extensive experience as Resident Engineer on major contracts, preferably on hydro-electric construction. Wide experience in rock tunnelling and large concrete dam work is essential.

(b) TWO RESIDENT ENGINEERS, each to be responsible under the Chief Resident Engineer for supervising approximately half of the civil engineering work.
Applicants for these two posts must be Associate Members of the Institution of Civil Engineers, preferably aged between 35 and 45, and must have had good experience in supervising construction of large civil engineering contracts, perferably on hydro-electric works. Good experience on rock tunnelling or large concrete dam construction is essential.

Salaries will depend upon the applicant's age and experience. Consolidated salary for post (a) above will be not less than £4500 per annum, and for posts (b) not less than £3800 per annum. Appointments will be for a period of about 5 years for post (a) and about 4 years for posts (b). Successful applicants will be required to take up the appointments early in 1959.

Generous leave on full pay, accommodation at concessionary rental or hotel allowances, free passages, medical and other concessions.

Engineers for the scheme are Messrs. Preece, Cardew and Rider, Consulting Engineers, 8, 10 and 12, Queen Anne's Gate, Westminster, S.W.1, associated with Messrs. Binnie, Deacon and Gourley, Chartered Civil Engineers, Artillery House, Artillery Row, Westminster, S.W.1. Successful applicants will be in the employ of the Engineers.

Written applications, with age and full particulars, to reach Messrs. Preece, Cardew and Rider, not later than 25th September, 1958. Interviews will be held in London during the first week in October and if required to attend, the applicant, whether in U.K. or overseas, will be paid out of pocket travel expenses. E8380

RAUCEBY HOSPITAL, SLEAFORD

ASSISTANT ENGINEER

ASSISTANT ENGINEER required at Rauceby Hospital, Sleaford. Candidates must have completed an apprenticeship or have otherwise acquired a sound practical training in mechanical engineering. It is desirable that they should hold, or be willing to study for, a recognised technical qualification.

Salary scale £555–£675. National Health Service conditions. Unfurnished house available.

Detailed applications, with the names of two referees, should reach the Group Secretary, Lincoln No. 3 Hospital Management Committee, Harmston Hall, Nr. Lincoln, within 10 days of the appearance of this notice. E8378

NEW SOUTH WALES DEPARTMENT OF PUBLIC HEALTH, SYDNEY, AUSTRALIA

RADIATION BRANCH, DIVISION OF INDUSTRIAL HYGIENE

OFFICER-IN-CHARGE

Applications are invited for appointment to the position of OFFICER-IN-CHARGE, Radiation Branch, Division of Industrial Hygiene.

Salary £A2000 to £A3000 per annum. Commencing rate according to qualifications and experience. Applicants must possess a University degree in Science or Engineering, with majors in Physics and/or Mathematics, or other equivalent qualifications. Special experience in radiational work is essential. The successful applicant will be mainly concerned in the administration of the Radioactive Substances Act and Regulations thereunder and will be required to organise and administer a new Branch of the Department. He will be required to advise the Department in all matters pertaining to radioactive isotopes and irradiating apparatus in regard to which he must have thorough experience.

Administrative experience is also desirable.

First class ship fares to Sydney of appointee and family will be paid.

Successful applicant will be eligible, subject to passing a medical examination, to contribute to the State Superannuation Fund.

Four copies of applications (including the names of two referees) should be lodged with the Agent General for New South Wales, 56, Strand, London, W.C.2, by the 7th October, 1958. E8421

PUBLIC APPOINTMENTS

ELECTRICITY AUTHORITY OF CYPRUS

APPOINTMENT OF RESIDENT ENGINEER

A RESIDENT MECHANICAL AND ELECTRICAL ENGINEER is required in Cyprus to supervise the installation of mechanical and electrical plant forming an extension to the Electricity Authority's Power Station at Dekhelia. The present extension includes one 14MW steam turbo alternator, two 90,000 lb. per hour oil-fired boilers with associated auxiliaries, pipework, switchgear, cables, &c.

Applicants should be Corporate Members of either the Institution of Mechanical Engineers or the Institution of Electrical Engineers and should have had previous experience of Power Station construction work.

The salary of the post will be £2250 per annum and the appointment will be for a period of eighteen months in the first instance.

The successful candidate will be required to take up his duties in Cyprus immediately.

Quarters with heavy furniture will be provided by the Authority who will also provide such local transport as is necessary for the work, but this will not be available for private purposes.

First class passages up to a maximum of three will be paid from England to Cyprus at the commencement of duty for the successful applicant and his family, and also from Cyprus to England on satisfactory completion of the engagement. Air travel may be necessary at the option of the Authority.

The selected candidate will be required to pass a medical examination.

Leave with pay at the rate of 2½ days per completed month of residential service will be granted after the completion of an eighteen month tour of duty.

Applications giving age, qualifications and experience should be addressed to :

Messrs. Preece, Cardew & Rider,
8–12, Queen Anne's Gate,
Westminster, S.W.1,

within fourteen days of the appearance of this advertisement.

E8370

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

DESIGN AND DEVELOPMENT ENGINEER

Have you a wide experience in designing and developing machine tools for repetition work ? Would you like to use your knowledge and skill in a practically untouched field ? If so, you may be the man we are looking for to devise special-purpose machines for the finishing of some of the steel industry's products. The position demands ability to work on own initiative and to apply basic results already obtained by an established research team. Any necessary metallurgical and engineering support will be provided.

The salary offered is in the range of £1100–£1250 p.a., and the post, in our laboratories at Sheffield, is permanent and pensionable.

Please write, giving details of experience and qualifications, to Personnel Officer, B.I.S.R.A., 11, Park Lane, London, W.1, quoting reference " F.8." E8395

WEST GLOUCESTERSHIRE WATER COMPANY

APPOINTMENT OF AN ASSISTANT ENGINEER

Applications are invited from suitably qualified engineers for the post of an ASSISTANT ENGINEER at a salary of £1025 to £1175 per annum (A.P.T. Grade IV). Candidates must have sound waterworks experience.

The company have a pension scheme and can also arrange for continuance of membership in the Local Government Superannuation Scheme. A car allowance is available.

Intending candidates should write to the undersigned for further particulars and should submit their applications, accompanied by three recent testimonials, not later than 11th September, 1958.

W. G. CLOSE, A.M.I.C.E., A.M.I.W.E.,
General Manager and Engineer.
Kingswood,
Bristol. E8335

PUBLIC APPOINTMENTS

WEST MIDLANDS GAS BOARD

BIRMINGHAM AND DISTRICT DIVISION

ASSISTANT MECHANICAL ENGINEER

Candidates should have served an apprenticeship in engineering and have had further experience in general engineering and steam plant. Possession of an Engineering Degree, Membership of the Institution of Mechanical Engineers, or a Higher National Certificate is essential. Some knowledge of mechanical handling plant and/or experience on work study as applied to maintenance work would be an advantage.

The person appointed will be required to assist in the maintenance work on gas works plant and the installation of new plants.

The salary will be in accoradnce with Grade A.P.T. 12 (£945–£1070 per annum) of the National Salary Scales for Gas Staffs.

The post is pensionable and the successful candidate may be required to pass a medical examination.

Applications, stating age, training, qualifications and experience, together with the names of two referees, should be sent to Mr. J. E. Wakeford, Divisional General Manager, West Midlands Gas Board, Gas Offices, Edmund Street, Birmingham, 3, to reach him not later than the 6th September, 1958.

J. SWAN,
E8394 Secretary to the Board.

CENTRAL ELECTRICITY GENERATING BOARD

NORTH EASTERN DIVISION

STEAM TESTING DEPARTMENT

SECOND ASSISTANT ENGINEER

Applications are invited for the appointment of a SECOND ASSISTANT ENGINEER in the Steam Testing Department with Headquarters at Dunston, to control a small section investigating the thermal performance and operating characteristics of a wide variety of modern steam plant. The work demands considerable initiative, and offers experience of testing techniques in an interesting field. Applicants should be corporate members of the Institution of Mechanical or Electrical Engineers, and should have previous plant testing experience. A knowledge of power station operation will be considered an advantage. The salary for the appointment will be in accordance with the National Joint Board Agreement, Schedule " B " Grade 4 (£1145–£1375) and will commence at a point commensurate with qualifications and experience.—Forms of application may be obtained from any office of the Generating Board, or from Divisional Establishments Officer, Central Electricity Generating Board, North Eastern Division, Carliol House, Newcastle upon Tyne, 1, to whom they should be returned to arrive not later than 1st October, 1958. E8430

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Royal Naval Scientific Service requires SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS for Establishments in London area, Baldock, Portsmouth, Portland, Poole, Greenock and Rosyth. Main requirements are about 25 vacancies for PHYSICISTS, ELECTRONIC ENGINEERS and MATHEMATICIANS in areas specified. The following particular vacancies also exist : MECHANICAL ENGINEER for work on gas turbine problems in the London area. MECHANICAL ENGINEER for work on design and development of U/W devices in Portland area, METALLURGISTS for Rosyth and Poole, CHEMISTS (Physical and Inorganic) for Poole area, Baldock and London. Candidates must normally be natural born British subjects of natural born British parents, with at least First or Second Class Honours degrees or equivalent high professional attainments. S.S.O.s must have had at least three years' post-graduate experience and be not less than 26 years of age. Salaries (men) S.S.O. £1190–£1410 ; S.O. £635–£1110 (London)—somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between the ages of 21 and 32 to compete for established posts.—Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A98/8A. E8092

A.E.R.E. HARWELL

ENGINEERING ESTIMATES

An apprenticed or similarly trained technician is required to prepare cost estimates of mechanical and electrical components for the Proton Synchrotron (Particle Accelerator) and to relate contracts to estimates. H.N.C. or equivalent in Mech. or Elec. Engineering and knowledge of building construction, civil engineering, specifications for engineering plant or contract procedure desirable.

Salary: £1050–£1270 (Technical I). Staff conditions.

Send POST CARD for application forms and details to Group Recruitment Officer (1194/25), U.K.A.E.A., Atomic Energy Research Establishment, Didcot, Berks.

E8400

PUBLIC APPOINTMENTS

NORTH WEST SUSSEX JOINT WATER BOARD

APPOINTMENT OF ENGINEERING ASSISTANT

Applications are invited for the post of ENGINEERING ASSISTANT at the Board's Offices, Washington, Pulborough, Sussex.

The salary will be in accordance with A.P.T. Grade III £845 by £35 to £1025 per annum, and the appointment will be terminable by one month's notice on either side.

Applicants should have a sound Waterworks training, specifically in connection with distribution, mains, waste prevention and stores organisation.

Applications on the Form to be obtained from the Office of the Chief Engineer, Mr. E. R. Griffiths, A.M.I.C.E., Washington, Pulborough, Sussex, should be completed and returned not later than Tuesday, 23rd September, 1958.

Canvassing will disqualify.

FREDERICK CLARK,
Clerk of the Board.

E8374

OPPORTUNITIES IN A NEW FIELD OF APPLIED PHYSICS

in the
Industrial Group
of the
UNITED KINGDOM ATOMIC ENERGY AUTHORITY
at Risley, Warrington, Lancashire
FOR MEN
with a sound training in
ENGINEERING, PHYSICS OR APPLIED MATHEMATICS

The work, which is of considerable and growing importance, covers the safety assessment of new chemical plant and laboratories. This includes studies at all stages, of design, construction and operation. There is a particular need of staff to assess criticality hazards in the handling and processing of fissile material. Initiation of investigations into factors governing criticality and the effects of super-criticality will also be undertaken. Corporate Membership of a senior Engineering Institution, or equivalent, is essential. An Honours Degree in Chemical Engineering, Mathematics or Physics, together with some post-graduate experience, will be an advantage.

Previous knowledge of the subject of criticality is not essential, as initial training can be provided for successful candidates.

Salaries will be assessed according to qualifications and experience within the scales

£1790-£2080, £1300-£1740
or £815 (at age 25) to £1270

Contributory pension scheme.

Housing or assistance towards legal expenses on house purchase may be available.

Send postcard for application form, quoting reference 2467, to Recruitment Officer at above address.

Closing Date: 8th September, 1958.

E8377

EDUCATIONAL

THE POLYTECHNIC,
309, REGENT STREET, W.1.

CIVIL AND MECHANICAL ENGINEERING DEPARTMENT

Head of Department :
R. W. STEED, B.Sc.(Eng.), Ph.D., A.M.I.C.E., A.M.I.Mech.E.

Evening Courses are held for the award of National Certificates in Civil and Mechanical Engineering and offer preparation for the examinations of the professional institutions.

Courses are also held in Engineering Workshop Practice.

Session begins on 22nd September, 1958. New students will be enrolled on Wednesday, 17th September, 5–8 p.m.

Prospectuses may be obtained on application to the Director of Education. E8375 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

TENDERS

ELECTRICITY SUPPLY BOARD (IRELAND)

STEAM STATION AT BELLACORICK, CO. MAYO
CONTRACT B

CIVIL ENGINEERING CONSTRUCTION

The Electricity Supply Board invites TENDERS for the civil construction work for a proposed power station at Bellacorick, Co. Mayo, to house two 20,000kW turbo-generators and two boilers, each 210,000 lbs. steam per hour M.C.R. capacity.

The work comprises generally :

Section I : The construction of power station buildings, consisting of boiler house, engine room, workshop, offices and ancillary buildings, cooling water system and general site work.

Section II : The construction of a reinforced concrete hyperbolic type cooling tower, approximately 290ft. high and 210ft. diameter at ground level.

Work on Section II will not begin until January, 1961.

Contractors may tender for either or both of the above Sections.

Forms of Tender, General Conditions of Contract, Specification, Bill of Quantities and Drawings may be obtained from the Board's Chief Engineer, Civil Works Department, 21, Lower Fitzwilliam Street, Dublin, for either Section I or Section II on deposit of £26 5s. 0d. (twenty-five guineas) or for both Sections I and II on deposit of £52 10s. 0d. (fifty guineas). These deposits will be returned on receipt of a bona-fide tender not subsequently withdrawn. Additional copies of the contract documents for either Section may be obtained on payment of £10 10s. 0d. (ten guineas) which will not be returnable.

Sealed Tenders endorsed "Tender—Bellacorick Power Station" must be lodged with the undersigned not later than twelve noon on Monday, 13th October, 1958.

The Board does not bind itself to accept the lowest or any tender.

PATRICK J. DEMPSEY,
Secretary.

Electricity Supply Board,
27, Lower Fitzwilliam Street,
Dublin. E8404

CITY AND COUNTY OF KINGSTON UPON HULL

CITY ENGINEER'S DEPARTMENT

NEW DRYPOOL BRIDGE OVER RIVER HULL

TO BRIDGE AND STRUCTURAL ENGINEERS

The Corporation is prepared to receive TENDERS for the CONSTRUCTION and ERECTION of a ROLLING LIFT BASCULE BRIDGE, 105 feet span, 70 feet overall width, over the River Hull.

The work includes the removal from the river bed of the foundation cylinders and protective timber dolphins of the existing bridge, the sinking under compressed air of 2 No. new Cylinders, the construction of Mass Concrete Abutments, Reinforced Concrete Piled Foundations to the Machinery Houses and Abutments, 8ft. diameter Cast Iron Lined Shafts and Subway under the River, the Steel Lattice Girder Bascule Span, Light Alloy Flooring to the Bascule Span, Steel Framed Machinery Houses encased in Brickwork and Masonry, Reinforced Concrete Beam and Slab Fixed East Approach Span of Reinforced Open Pile construction, Timber River Protective Works, etc.

Tenders are desired from Bridge and Structural Engineering Firms, who must tender for the whole of the work, but they may sublet the Foundations, Concrete and Reinforced Concrete, the General Building Works and the Light Alloy Bridge Flooring. The Operating Machinery, the Motors, the Electrical Control Equipment and the Roadworks will be the subject of separate contracts.

The drawings may be seen and the Contract Documents obtained at the City Engineer's Office, or the Documents will be forwarded, on payment of £10 (Ten Pounds) to the City Treasurer, which payment will be refunded on receipt of a bona fide tender and the return of all documents duly completed.

The Tender and Bill of Quantities filled up and signed by the persons tendering, together with the General Conditions and Specification are to be enclosed in the special envelope provided and delivered at the Town Clerk's Office, Guildhall, Kingston upon Hull, addressed to the Chairman of the Bridges, Old Harbour and Pontoon Sub-Committee before 12.00 noon on Tuesday, 30th September, 1958. The Corporation does not bind itself to accept the lowest or any Tender.

WM. MORRIS,
O.B.E., M.I.C.E., F.R.I.C.S.
City Engineer.

Guildhall,
Kingston upon Hull. E8414

EDUCATIONAL

NOTICE

UNIVERSITY OF MANCHESTER

The next SESSION COMMENCES on THURSDAY, 2nd OCTOBER, 1958.

E8251 E

EDUCATIONAL

COUNTY BOROUGH OF DARLINGTON EDUCATION COMMITTEE

COLLEGE OF FURTHER EDUCATION

HIGHER NATIONAL DIPLOMA COURSE IN MECHANICAL ENGINEERING

This four-year full-time (Sandwich) Course is broad based and carries a high production engineering content. Hydraulics and electrical Engineering are studied as ancillary subjects up to the third year.

Entry is open to those who have either obtained a good pass in the second (S2) year of the Ordinary National Certificate or who possess G.C. of E. passes in approved subjects at Advanced level.

Particulars and entry forms may be obtained from the Principal, College of Further Education, Cleveland Avenue, Darlington.

D. PETER,
Chief Education Officer.

E8397 E

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

ENFIELD TECHNICAL COLLEGE
QUEENSWAY, ENFIELD, MIDDLESEX
(Telephone : HOWard 1126.)

Applications are invited for admission to full-time Sandwich Diploma Courses in Civil, Electrical, Gas, Mechanical and Production Engineering, in Furniture Production Engineering, in Foremanship and Supervision and in Management Studies.

Full details of the Courses may be obtained from the Principal.

C. E. GURR, M.Sc., Ph.D.,
Secretary to the Education Committee.

E8373 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A GRADUATE METALLURGIST with little or no industrial experience is required for interesting work in the Development Department of an old-established non-ferrous metals company in S.W. Lancs. Candidates should submit in strictest confidence, full details of education and qualifications to BOX No. 16762, C. Vernon and Sons, Ltd., Advertising Agents, 74, Rodney Street, Liverpool, 1.

E8433 A

APPLICATIONS ARE INVITED for the following appointment at the CLAYDON, SUFFOLK, Works of THE BRITISH STEEL PILING CO., LTD.

SENIOR DESIGNER DRAUGHTSMAN (Minimum qualifications H.N.C. or equivalent).

Minimum age 28 years. Candidates should be capable of accepting responsibility for complete projects.

THIS APPOINTMENT IS PERMANENT AND PROGRESSIVE IN AN EXPANDING ORGANISATION and the successful candidate will be engaged on interesting work in connection with special crane type structures, hoisting machinery (steam, diesel, electric) and contractors' plant.

Contributory Pension Scheme in operation. Good Canteen facilities. The Works are situated 15 minutes' bus ride from the centre of Ipswich.—Apply in writing, giving full particulars of age, experience, qualifications and salary required, to the Personnel Officer at the above address. E8418 A

ASSISTANT CIVIL ENGINEER required for a position in an integrated iron and steel works. Applicants should have experience in iron and steel works maintenance. Experience also desirable in reinforced concrete, foundations and building design. A qualification is desirable.—Applications, giving age and full details, should be sent as soon as possible to the Chief Engineer, GUEST KEEN IRON AND STEEL COMPANY, Ltd., East Moors, Cardiff. E8389 A

ASSISTANT RESIDENT ENGINEER required for road improvement contract in Nigeria. Good knowledge of road soil mechanics and testing procedure required. Salary range £1200 to £1500. Free furnished accommodation and local transport. Facilities on site suitable for men only. Two years' tour and five months' paid U.K. leave.—Apply in writing only, stating details of experience and previous positions held, to Ref. N.1, R. Travers Morgan and Partners, 7, Victoria Street, London, S.W.1.

E8396 A

CHIEF DESIGNER required for manufacturer of Commercial and Municipal Bodywork, Trailers and Semi-trailers. Midlands area. Apply, stating age, experience and salary required, in confidence, to the Managing Director.—BOX No. E2061, "The Engineer." A

CHIEF ENGINEER required for modern works in the Midlands, engaged in the production of light alloys in all wrought forms (sheet, strip, extrusions, wire, tube, pressings and forgings). The post is one demanding organising ability, in addition to the obvious requirement of a first-class training in mechanical and electrical engineering. The duties cover the complete charge of a large engineering department. This includes a drawing-office handling the design and specification of all machinery and plant and workshops dealing with the manufacture, erection, maintenance and repair of all plant, services and equipment. A knowledge of general heavy engineering is essential, preferably associated with rolling mills and hydraulics. The salary will be in accordance with training and experience, the position being a progressive one offering an excellent opportunity to a man between 35 and 45. Applicants should give chronological details of their training and experience, and state age and salary level expected.—BOX No. E8325, "The Engineer." A

CRANE DESIGN AND DETAIL DRAUGHTSMAN, qualified, and with experience of Jib and Goliath Cranes, required for Glasgow office of National Established Consulting Engineers. Commencing salary not less than £900 p.a. Pension and Insurance Schemes.—BOX No. E8440, "The Engineer." A

SITUATIONS VACANT

CONSTRUCTIONAL ENGINEER required for supervision of installation of Capital plant in foundries. Practical experience of site supervision essential and some drawing office experience preferred. Age between 25 and 35. Car provided.—Apply in writing to Managing Director, Fuel and Metallurgical Processes, Ltd., Normanhurst Chambers, 21, St. James' Road, Dudley, Worcs. E2058 A

DE HAVILLAND PROPELLERS LIMITED
L.R.B.M.
DEPUTY DESIGN ENGINEER

A Senior Design Engineer is required as Deputy to the Engineer in Charge of the Ground Equipment Design Group, comprising some fifty staff.

He must have solid experience in the following fields :—

Welded Steel Structures.
Reinforced Concrete and Civil Works.
Vehicles and Transport Equipment.
Electrical, Hydraulic and Pneumatic Systems and Installations.
Preparation of Technical Specifications.
Administration and Supervision of Design Staff.

In addition, acquaintance with the following is desirable :—

Testing and development of machines and heavy equipment.
Instrumentation.
Sub-Contract manufacture of equipment.
Detailed programme and progress control.

As may be seen from the above, a feature of this post is the wide technical variety of the work, and this appeal is therefore directed towards a versatile man (aged 35 to 50, say) with all-round experience.

Academically, he should be up to B.Sc. Eng. standard, but experience is the main consideration.

If you are chosen, you will be based on our London Office, but will make frequent visits in the U.K. and occasional trips abroad.

Please write, quoting Ref. 201, call or telephone, Mr. G. O. Russell, CHAncery 3399, DE HAVILLAND PROPELLERS LIMITED, 37/38, John Street, Theobalds Road, London, W.C.1. E8390 A

DESIGN ENGINEERS required for London civil engineering office. Experience in R.C. and steelwork essential. Good salary and prospects. Pension fund. Free luncheons.—Write age, qualifications and experience (I.A.M./130), BALFOUR, BEATTY AND CO., LTD., 65, Queen Street, E.C.4. E8387 A

DRAUGHTSMEN required by Mid-Tyne firm of marine engineers for work on engine room pipe arrangements, engine and boiler details. Write, giving details of experience.—BOX No. E8362, "The Engineer." A

HEAVY ELECTRICALS PRIVATE LTD., BHOPAL

Applications invited for undermentioned posts with H.E.P.L. :—

(a) 4 PROCESS AND PLANNING ENGINEERS.
(b) 3 TOOL ENGINEERS.
(c) 68 JUNIOR SUPERVISING ENGINEERS.
(e) 1 CHEMIST.
(f) 1 METALLURGIST.
(g) 1 OSCILLOGRAPHER.
(h) 1 LIBRARIAN.

Applications should be made to the High Commission of India, Establishment Department, India House, London, W.C.2, before the 6th September, 1958.

Qualifications required for (a), (b) and (c)—Degree or diploma in Mechanical or Electrical Engineering and four years' practical training and experience in engineering workshop. Pay scale Rs. 275–800. Age below 30 years.

Qualifications required for (e)—First Class B.Sc. (Hons.) or M.Sc. in Organic Chemistry (Analytical) and three years' laboratory experience in industrial concerns. Will be in charge of chemical laboratory equipped with organic and inorganic sections. Required to deal with insulating materials as Analytical Organic Chemist. Pay scale : Rs.350–850 or Rs.600–1150. Age between 27–35 years.

Qualifications required for (f)—Degree in Metallurgy and two years' post-graduate apprenticeship in industrial establishment. Five years' experience in modern industrial laboratory or works involving mechanical, metallurgical or radiological testing of engineering materials, foundry castings, &c. Pay scales : Rs.350–850 or Rs.600–1150. Age between 27–35 years.

Qualifications required for (g)—Degree in Electrical Engineering and experience in electrical measurement. Preferably experience also in use of oscillographic equipment. Pay scale : Rs.350–850. Age between 28–35 years.

Qualifications required for (h)—First Class B.Sc. (Hons.), B.A. (Hons.), or M.A. from University possessing recognised Librarian qualifications and four years' experience with technical reference library. Corporate Membership of recognised Libraries Association with training in the specialised line will be preferred. Librarian will be in charge of reference literature on science and technology attached to factory. Pay scale : Rs.275–800. Age between 25–35 years. E8422 A

IMPERIAL CHEMICAL INDUSTRIES, LTD., requires a TECHNICAL ASSISTANT for its Standards Section in London, for work relating to engineering plant and general stores equipment. It is essential that candidates should hold the Higher National Certificate or equivalent qualification and have had practical and drawing-office experience. As the duties of the post include liaison and committee work, candidates must have first-class personal qualities and be able to express their ideas clearly and concisely.—Applications, giving age and experience, should be made to Head Office Staff Department (WDAM), Imperial Chemical House, Millbank, London, S.W.1. E8384 A

Classified Advts. continued on page 92

SITUATIONS VACANT

EXPERIMENTAL AND RESEARCH ENGINEERS

British Nylon Spinners continue to expand and invite applications from Corporate and Graduate Members of the Institution of Mechanical Engineers interested in Experimentation and Research.

The work covers a field including Machine Dynamics, Heat Transfer, Servo Control Systems, Electronic Circuit Design, Analogue Simulations and Stress Problems.

Each Engineer must be capable of undertaking a variety of such problems, for which, primarily, he will be solely responsible. He should have, therefore, high academic qualifications and a real feeling for this type of work. The works are most attractively situated, while conditions of employment are equivalent to the best obtainable. Likely applicants will be invited to meet the Engineering Staff in order to discuss the work.

Rented houses may be made available to married staff while assistance is given with removal expenses.

Please write, quoting Ref. 77, to the Personnel Manager, British Nylon Spinners, Pontypool, Monmouthshire.

E8274 A

FOREMAN PIPE LAYER required to supervise direct labour teams engaged on the installation of water services on a large-scale engineering project in the North of England. Applicants should have extensive experience in laying steel and cast-iron pipes up to 36in. diameter with standard types of joints, although experience of welded joints is not essential. —Write, giving details of age, experience to date and salary required to : British Oxygen Wimpey, Ltd., M. and E. Department, Spadeadam Research Establishment, Gilsland, Near Carlisle. E8294 A

HEAT TRANSFER ENGINEER required for customer liaison. Experience in design and development of all types of heat exchangers and preferably with connections in the aircraft industry. Applicants with sound technical and executive experience should write, giving full details of experience and qualifications.—BOX No. E8392, "The Engineer." A

JACKSON BROS (OF KNOTTINGLEY) LTD.

have vacancy for an ENGINEER for maintenance and development work in modern glass-producing factory.

Candidates should have served an engineering apprenticeship, be Corporate Members of the Institution of Mechanical Engineers, or have H.N.C. in Mech. Eng. and be between 25 and 30.

Successful candidate will be one of a team responsible to Chief Engineer for maintenance of air compressors, pumps, fans, steam-raising plant, fuel oil pumping and storage installations, mechanical handling plant and general factory building maintenance, &c.

The operation and development of a preventive maintenance system and administration of services departments will be the successful applicant's main concern.

Replies in first instance, giving full details of experience, technical qualifications and salary required, should be addressed to Personnel Officer, Jackson Bros. (of Knottingley), Ltd., P.O. BOX No. 2, Knottingley, Yorks.

E8345 A

MARINE ENGINEERS.—An opportunity arises for several men to undergo training in connection with the application of nuclear energy to the propulsion of merchant ships. Applicants must hold a B.Sc. Degree in Marine or Mechanical Engineering and have some drawing-office experience in marine engineering. Also, experience in the operation of marine machinery at sea will be an advantage. Training of successful applicants will take place initially in the Midlands, and applications giving full details, which will be treated with strictest confidence, should be addressed to the Manager, Marine Propulsion Research and Development Dept., Vickers-Armstrongs (Engineers), Ltd., Barrow-in-Furness, Lancashire. E8385 A

MECHANICAL ENGINEER : VENEZUELA

TWO MECHANICAL ENGINEERS, age 35 or under, are sought for 100MW steam power station in Venezuela. Qualifications required are :

Higher National Certificate, University Degree or Corporate Membership of Institution of Mechanical Engineers or equal.

At least five years of operating and maintanance experience in a responsible position with steam generating plant of 50MW or higher.

Knowledge of Spanish would be useful. Salary paid in U.S. dollars will be on a generous scale. Full details should be forwarded by post, quoting Ref. 2409, to : Messrs. Mackness and Shipley, Consulting Engineers, Parliament Mansions, Abbey Orchard Street, London, S.W.1. E8413 A

PROJECTS ENGINEER—A large engineering Company in the north-west due to policy of diversification, requires an EXECUTIVE ENGINEER to be responsible for controlling entirely new department for handling promotion and sales of new projects. Applicant must be an experienced and fully trained Engineer aged 35/40. A four-figure salary will be paid and conditions of service include a contributory pension scheme and a Company car.—Write giving full particulars of education, past experience, qualifications and age to BOX No. 298, Dorland Advertising, Ltd., 18–20, Regent Street, London, S.W.1. E8432 A

RESEARCH ENGINEER, Mechanical or Chemical. Young Honours Graduate required for research on methane combustion for acetylene synthesis. Starting salary £700–£750, according to qualifications and experience.—Apply, Chief Engineer, Nardac Laboratory, Mogden Lane, Isleworth, Middlesex. E8383 A

MECHANICAL ENGINEER required by National Coal Board's Reconstruction Dept. in London. Duties include the engineering aspects of the general arrangement of the colliery surface, and assistance in the preparation of basic standards for the planning of surface layouts. Applicants should have appropriate technical qualifications ; colliery experience or service with manufacturers of colliery equipment would be an advantage.—Appointment (superannuable) within inclusive range £1914–£2564 depending on qualifications and experience.—Write, with full particulars, to Staff Manager (X1225), N.C.B., Hobart House, London, S.W.1, before 10th September, 1958. E8426 A

MECHANICAL ENGINEER

with some electrical knowledge required to join group engaged on design and Site supervision of oil products pipeline and distribution depots in Iran. Knowledge of petroleum practice is essential. Applicants should be qualified, aged about 35, and have design experience of pumping and ancillary equipment. The successful applicant will be required to work in London office in the first instance.—Send fullest particulars to : Staff Office, Rendel, Palmer and Tritton, Consulting Engineers, 125, Victoria Street, London, S.W.1.

E8330 A

PROGRAMME ENGINEER AND TECHNICAL CLERK REQUIRED on work involving and preparation of programmes for the installation of large-scale chemical and mechanical engineering work in the North of England. Applicants should have served in recognised engineering apprenticeships. —Write, giving details of age, experience to date and salary required to : British Oxygen Wimpey, Ltd., M. and E. Department, Spadeadam Research Establishment, Gilsland, near Carlisle E8295 A

RUBBER IMPROVEMENT LTD., WELLINGBOROUGH

require ELECTRICAL AND INSTRUMENT ENGINEER who must have a wide knowledge and practical experience of electrical and control instruments employed on rubber and plastics manufacturing machinery of all kinds. The appointment carries a good salary and a non-contributory staff pension and life insurance scheme is in operation. Applications, which will be treated in strict confidence, should be addressed to the Secretary. E8416 A

SALES ENGINEERS. Birlec, Ltd., Birmingham, 24, have several excellent opportunities in expanding Sales Division to deal with electric and gas heat treatment furnaces. Good engineering education, appearance and letter writing ability essential. Non-contributory pension scheme.—Apply in writing giving details of training, experience and salary expected to Personnel Officer (JMP). E8402 A

SALES MANAGER AUTOMOBILE GEAR DIVISIONS DAVID BROWN INDUSTRIES LIMITED

wish to appoint a fully experienced man as head of their U.K. Sales Organisation responsible for the sales of gears and transmissions to the Commercial Vehicle and Automobile Industry. The man appointed must have held a similar position and will be required to have established contacts at Director level in the Industries concerned. A sound engineering background with a knowledge of the specialist field of gears and transmissions is essential and a professional qualification would be an advantage. The position is permanent and pensionable and will be located at the Company's main gear works in Huddersfield. The high salary envisaged will be commensurate with the responsibilities of the position.

Applications should be addressed to the Director of Personnel, David Brown Companies, Durker Roods, Meltham, Near Huddersfield. E8429 A

SENIOR DESIGNER required by Diesel Engine Manufacturing Company. The successful applicant will be required to undertake major design work on small and medium-sized engines. The essential qualifications are Higher National Certificate and experience of reciprocating engine design. Excellent conditions of service.—Please apply in writing, giving full details of experience and salary required, to Chief Personnel Officer, PETTERS LIMITED, Causeway Works, Staines, Middlesex. E8419 A

SENIOR DRAUGHTSMEN required. Must have experience of plant layouts, machine design and pipework installation. Suitable posts for men wishing to broaden experience in a wide range of processing plant. Good progressive salaries to suitable applicants. Staff canteen, pensions and sickness benefit schemes, &c.—Please apply to Personnel Manager, John Knight, Ltd., Royal Primrose Soap Works, Silvertown, E.16. E2067 A

SENIOR SALES REPRESENTATIVE—required for the newly-formed Contract Sales Division of a large engineering Company in the north-west. Sales are directed to all types of engineering industries and comprise speciality products, foundry and machining work in the form of assemblies and precision components. This is an attractive and progressive post and calls for considerable experience in selling direct to industry. Applicants should have a good technical knowledge of foundry work and machine shop practice. A good salary will be paid and a Company car provided. A contributory pension scheme is in operation.—Applicants should give full particulars of education, past experience, qualifications and age to BOX No. 300, Dorland Advertising, Ltd., 18–20, Regent Street, London, S.W.1. E8431 A

TECHNICAL ASSISTANT required for initial design calculations and subsequent testing of aircraft and commercial heat exchangers. H.N.C. or above. Post-graduate experience also offered in this field. Write, stating age, experience and salary required.—BOX No. E8391, "The Engineer." A

SITE ENGINEERS required for supervision of Mechanical and Instrumentation work on a large-scale project in the North of England. Duties will include organisation and supervision of direct labour and Sub Contractors. Applicants should preferably be Corporate members of a Senior Institution and have appreciable experience in one or both of the above fields of work.—Write giving details of age, experience to date, and salary required to : British Oxygen Wimpey, Ltd., M. and E. Dept., Spadeadam Research Establishment, Gilsland, near Carlisle. E8296 A

THE FOLLOWING STAFF ARE REQUIRED for small design team doing varied and interesting work on gas turbines and compressors in Home Counties.

(1) ENGINEER.—25/30 years. H.N.C. or equivalent, for original mechanical design. Must be capable of working on own initiative and show imagination. Gas turbine experience advantageous.

(2) ENGINEER.—H.N.C. or equivalent, for basic design work and performance analysis.

Both posts carry excellent superannuation provisions, and working conditions very good. Full details in confidence.—BOX No. E2037, "The Engineer." A

THE UNITED GLASS BOTTLE MANUFACTURERS, LTD., Anchor and Hope Lane, Charlton, S.E.7. An opening occurs for an apprentice-trained JIG AND TOOL DESIGNER, aged 25–30 years, minimum qualification O.N.C., who has at least five years' experience of batch production methods. The post, which is pensionable and carries an attractive salary, offers excellent prospects for a man of initiative capable of working with the minimum of supervision. —Please write to the Personnel Officer, stating age, qualifications, experience and salary required. E8364 A

THE WORLD'S LEADING INVENTORS and Manufacturers of special-purpose precision machinery for the tobacco industry have opening in their Patent Department for a

TECHNICAL ASSISTANT

This is a progressive appointment offering a first-rate opportunity to a suitably qualified man, ideal age about 30. The work involves mainly mechanical engineering, but involves also electrical/electronic engineering as an important subsidiary.

Applications, stating age, qualifications and experience should be personally addressed in confidence to the Personnel Manager :

MOLINS MACHINE CO., LTD.,
Evelyn Street, London, S.E.8.

E8369 A

VACANCIES AVAILABLE for TECHNICAL ESTIMATING and SALES REFRIGERATION ENGINEERS.—Apply in writing to Personnel Manager, J. and E. Hall, Limited, Dartford, Kent. E8401 A

WELL-KNOWN STEEL AND ENGINEERING ORGANISATION requires highly efficient executive with experience of and connections with the oil and light engineering industries. Position progressive. Prospect of early advancement and directorship. Applications will be treated in confidence.—Write, with full details of experience and names of three referees, BOX No. 206, c/o West End Advertising Agency, Ltd., 1/9, Hills Place, Oxford Street, London, W.1. E8379 A

WEST MIDDLESEX FIRM require immediately a competent ENGINEERING DRAUGHTSMAN, fully experienced in design of electro-mechanical devices.—BOX No. E136, "The Engineer." A

WORKS MANAGER wanted for old-established engineering firm making small to medium high-class machines of wide variety now employing thirty men. Tact necessary and wide experience in machine tools, fabrication, assembly and organisation. Objectives are firstly re-organisation, secondly, increase in scope and scale of manufacture. Preliminary applications should state age, and indicate salary required. Apply.—BOX No. E2069, "The Engineer." A

YOUNG ENGINEER required by a Company specialising in non-ferrous metals, for handling projects from the design stage on the drawing board, following through to machine construction and running in on the shop floor. A sound practical training and knowledge of engineering services is essential. Experience of non-ferrous metals would be an advantage. Candidates, who should be between 23–30, should write, giving full details of experience, qualifications, age, &c.—BOX No. E8403, "The Engineer." A

BRITISH OXYGEN WIMPEY LIMITED

require

INSPECTION ENGINEERS

to be based on a site in Cumberland for Survey of site fabrications, including Class (I) Vessels, Class (A) Welding of pipe lines, stainless steel materials, &c.

Progressive appointments on permanent staff with good commencing salary and contributory Pension Scheme. Only first-class men with several years' Inspection experience and Ministry of Transport 1st Class Certificate or equivalent need apply. Reply with details of age, experience, qualifications and present salary to :

Office Manager,
BRITISH OXYGEN WIMPEY LIMITED,
17, Monck Street, London, S.W.1.

E8425 A

SITUATIONS VACANT

FIRST CLASS TECHNICAL SALESMAN

age 35/40, required for Northern Counties by well-established engineering works in North Midlands, adequately equipped for production of Castings and Steel Fabrication to Lloyd's Class 2 Welding, also Rivetting, for Chemical Industry.

State experience, salary required, names of previous employers, and when available, enclosing three references.—BOX No. E8399, "The Engineer."

A

FIRST CLASS TECHNICAL SALESMAN

age about 40/45, required to work from London Office, by well established Engineering Works in North Midlands, adequately equipped for production of Castings and Steel Fabrication to Lloyd's Class 2 Welding, also Rivetting, for Chemical Industry.

State experience, salary required, names of previous employers and when available, enclosing three references.—BOX No. E8398, "The Engineer."

A

SHEEPBRIDGE ENGINEERING LIMITED

announce the following vacancies

at

CHESTERFIELD AND GLASGOW

for Designers with extensive experience in any of the following :—

Ref.

EQDa. Haulages and winches.

EQDb. Mining Equipment.

EQDc. Stone Crushing and Screening Application.

EQDd. Special purpose machines.

EQDe. Fibre Glass Products.

EQDf. Handling Plant and equipment as supplied to the Petroleum, Chemical, Gas, Quarry, Colliery and Iron and Steel Industries.

Positions to be filled in the following categories :—

1. CONTRACT DESIGNERS for dealing with project design and commercial and progress aspects of contracts.

2. SENIOR DESIGNERS responsible for design and production of all manufacturing details, with prospects of early promotion to Section Leader in a number of categories.

3. DEVELOPMENT ENGINEERS for original design and development work on New Products.

Five Day Week – – – – Overtime

Superannuation Scheme

Write in confidence, giving age, qualifications, experience and present salary, quoting appropriate reference, to :—

PERSONNEL MANAGER,
SHEEPBRIDGE ENGINEERING, LIMITED,
CHESTERFIELD.

E8388 A

SITUATIONS VACANT

SENIOR DRAUGHTSMEN
DESIGN ENGINEERS
and
DESIGN DRAUGHTSMEN

are offered progressive posts at

STEWARTS and LLOYDS
LIMITED · CORBY

. . . one of the largest integrated Iron, Steel and Steel Tube Works in Europe

MECHANICAL ENGINEERING

1. Department of New Development. For the design and development of plant and equipment. Applicants must have sound knowledge of heavy engineering, preferably in an Iron and Steel Works, and considerable experience of design work.

2. Tube Works Drawing Office. Senior Draughtsmen for layout, maintenance and improvement of plant and equipment. Applicants must have H.N.C., along with sound Drawing-Office experience in heavy engineering.

ELECTRICAL ENGINEERING

3. Department of New Development. For design of electrical equipment. Applicants must have a thorough knowledge of distribution and good Drawing Office experience.

Five-day week. Good welfare, canteen and recreational facilities. Superannuation and Life Assurance Schemes. Staff Hostel for single men. Excellent housing prospects. Good salaries based on experience and qualifications.

Applications will be treated as confidential, and should give age, details of qualifications, experience, salary required, department to which application refers. They should be addressed to :

Manager/Personnel,
STEWARTS AND LLOYDS, LIMITED,
Corby, Northants.

E135 A

THE BAHRAIN PETROLEUM COMPANY LIMITED
require a
MAINTENANCE ENGINEER

This post is open to recent graduates in Mechanical Engineering, under 28 years of age, who are interested in all phases of planned maintenance of heavy plant and who have preferably some experience on pressure vessel, heat exchanger and pump repair. It is intended that the selected candidate should train in Bahrain with a view to advancement to at least Area Engineer in the large and modern refinery there.

A good salary can be offered dependent on qualification, in addition to which air-conditioned accommodation is provided with an adequate living allowance, medical attention, kit allowance, and paid local and home leaves with participation in pension and provident fund plans.

Apply in writing (quoting MTC), with full particulars, to :

CALTEX SERVICES LIMITED,
CALTEX HOUSE,
KNIGHTSBRIDGE GREEN,
LONDON, S.W.1.

E8329 A

W. H. ALLEN SONS & COMPANY LTD. BEDFORD

require for their Production Engineering Department

WORK STUDY ENGINEERS

Experienced in the application of Work Study to machine or assembly shops.

DEVELOPMENT ENGINEERS

To investigate and improve manufacturing techniques.

DRAUGHTSMEN

For the design of Jigs, Tools, Fixtures and Tool Layouts.

These positions will interest men of sound education and practical experience, who can carry out on their own initiative, studies and investigations into problems affecting the small-batch production of Steam and Gas Turbines, Diesel Engines, Centrifugal Pumps and Electrical Machinery.

Please apply in writing, stating age, present salary and full details of education, training and experience to—

THE PERSONNEL MANAGER.

E8314 A

RICHARDSONS WESTGARTH (HARTLEPOOL) LIMITED

ELECTRICAL DRAUGHTSMEN

The Richardsons Westgarth Group of Companies is actively interested in the field of nuclear power and in a wide range of marine and general engineering.

There are opportunities at Hartlepool for senior and junior draughtsmen for design and detail work on turbo-generators. Men with experience of 100 M.W. sets and above will be preferred, but suitable applicants with experience of smaller machines will receive careful consideration. The prospects are excellent for the right men.

There are Pension and Life Assurance Schemes in operation.

Write to the Group Personnel Officer, Richardsons Westgarth & Co., Ltd., Northumberland Engine Works, Wallsend, Northumberland, quoting ref. No. H.8F.

E8439 A

SHELL

THE SHELL PETROLEUM COMPANY LIMITED
has a vacancy for an
ELECTRICAL ENGINEER
in their
MARKETING OPERATIONS DEPARTMENT

Candidates should be under 30 years of age and should hold a University Degree or equivalent qualification in Electrical Engineering. It is essential to have had a number of years' practical experience of electrical industrial installation practice, and experience of small-scale electrical generation would also be an advantage.
Initially, employment would be in London but successful candidate must be willing to serve overseas when required to do so.
The post is of a career nature with excellent prospects.
Commencing salary according to experience.

Please write in strict confidence, giving age, qualifications and experience, to

STAFF DEPARTMENT (R)
ST. HELEN'S COURT,
GREAT ST. HELEN'S,
LONDON, E.C.3.

E8366

SPERRY GYROSCOPE
BRACKNELL DIVISION

As a result of our recent campaign we have filled nearly all our vacancies for Engineers. There remain three rather special vacancies in our Guided Weapon teams at Bracknell ; for an electro-mechanical design and development engineer ; an engineer to design and develop specialised test fixtures ; and an engineer to investigate component and system reliability and advise on design changes if required.

Candidates for these posts should possess a full professional qualification and have at least five years' responsible experience in a related field.

Housing is available in certain cases.

Enquiries invited by Mr. R. W. H. Lubbock, B.Sc.,

SPERRY GYROSCOPE COMPANY, LTD.,
Bracknell, Berks.

E8376 A

SUPERINTENDENT OF ENGINEERING AND MAINTENANCE

required

for new fertiliser factory now under construction in TRINIDAD. He will direct and control plant engineering and maintenance as well as construction activities undertaken by the company.

Candidate must have had fifteen years' industrial experience of which ten years should have been in engineering, maintenance and construction. He must also have experience in maintenance practices on large compressors, gas or oil engines, pumps, tubular heat exchange equipment, fractionating towers, etc., etc. He must also have had at least five years' supervisory experience, of which two years should have been in charge of a chemical plant or a large section of a major chemical works. A knowledge of electrical equipment and stainless steel welding techniques would be advantageous.

A degree in engineering and corporate membership of an engineering institute is desirable.

The position is permanent and carries periodic home leave with passages paid for employee and his family.

Please apply in strict confidence to : Managing Director,

GRACE BROTHERS LTD., 143/9, FENCHURCH STREET, LONDON, E.C.3

E8420 A

SENIOR DESIGN AND DEVELOPMENT ENGINEER

BRITISH OXYGEN GASES, Limited, require for their Aircraft Equipment Works at Harlow a Senior Design and Development Engineer.

Applicants must have experience at a senior level in the airborne instrument or precision equipment field. A sound background of engineering or science is required coupled with a minimum qualification of H.N.C., a Degree being preferred.

In this post a lively and enthusiastic approach to engineering problems is desired. The emphasis will be on design and development but applicants must be capable of exercising technical control in the production stage.

A very good commencing salary is offered and the position is progressive. Accommodation is readily available at Harlow and consideration will be given to meet removal expenses, etc.

Write, stating full details of age, experience and qualifications, to **Personnel Manager, Spencer House, St. James's Place, London, S.W.1.**

E8393 A

RICHARDSONS WESTGARTH (HARTLEPOOL) LIMITED

SALES ENGINEER

Senior Sales Engineer required by expanding and progressive Company on the North-East Coast, engaged in the manufacture of generating plant for public utility and industrial concerns. Applicants must be experienced in the preparation and submission of tenders for turbo-alternators, condensing plant and feed heating systems. This is a Senior Staff appointment with a commensurate scale of remuneration.

A Pension and Life Assurance Scheme is in operation and a Senior Staff mess is provided. Reasonable costs of moving house will be reimbursed.

Applications, which will be treated in strict confidence, should give full details of training qualifications and experience, and a chronological list of previous appointments, and should be addressed to the Group Personnel Officer, Richardsons Westgarth and Co., Ltd., Northumberland Engine Works, Wallsend, Northumberland, quoting reference number H.7 E.

E8417 A

Classified Advts. continued on page 94

SITUATIONS WANTED

A.M.I.P.E.—ENGINEER, experienced in machine design, mechanical handling, plant layout, automation, lubrication, technical sales, buying, advertising, seeks Management appointment, Middlesex or London.—BOX No. E2068, "The Engineer." B

ENGINEER (37), A.M.I.Mech.E., A.F.R.Ae.S., apprenticed, seeks responsible post in South of England. Wide experience light/medium Mechanical Engineering including Design, Development, Administrative and Commercial. Offers initiative, enthusiasm and effort.—BOX No. E2070, "The Engineer." B

MISCELLANEOUS

TIME RECORDERS, Sales, Rentals, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157–159, Borough High Street, London, S.E.1. E110 I

PATENTS

THE PROPRIETOR of British Patent No. 730,410, for "IMPROVEMENTS IN AND RELATING TO LATTICE OR OPENWORK STRUCTURES," desires to enter into negotiations with a firm or firms for the Sale of the Patent, or for the grant of Licences thereunder.—Further particulars may be obtained from MARKS and CLERK, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E8382 H

THE PROPRIETOR of British Patent No. 709,777, entitled "Power Transmission Mechanism for Farm Implement," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E. Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E8410 H

THE PROPRIETOR of British Patent No. 709,968, entitled "Lashing Machine for Aerial Cables," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E. Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E8411 H

THE PROPRIETOR of British Patents Nos. 711,298, 711,299 and 709,958, entitled "Improved Plug Closures for Handholes and the like of Pressure Vessels," "A Gate Valve with an Improved Bonnet and Sealing Means Therefor," and "Improved Plug Closures for Hand and like Holes in Pressure Vessels," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E. Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E8412 H

THE PROPRIETORS of Patent No. 693,530, for "Improvements in or relating to Methods of Securing a Pin in a Member"; Patent No. 704,139, for "Improvements in or relating to Connections between Pins and Bores," desire to secure commercial exploitation by Licence or otherwise in the United Kingdom.—Replies to Haseltine Lake and Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. E8423 H

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process; sample castings treated; A.I.D. approved.—Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex (Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

PRECISION ENGINEERS.—Personal service for prototypes, small quantity machined parts and equipments. Design and development undertaken. A.I.D. Approved.—Bowyer, Smyth and Partners, Ltd., Vineyard Walk, Clerkenwell, E.C.1 ('Phone, TERminus 5113/4). E112 MW

METAL FABRICATIONS, ¼IN. THICKNESS, SPOT WELDING, PROFILE CUTTING, A.I.D. approved. Specialists in quick delivery.—Bankfield Engineering Co., Ltd., Southport (87427). E2046 MW

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THE EAST ANGLIAN ENGINEERING CO. LTD.,
including the
FREEHOLD FACTORY
at
LOWESTOFT
containing a floor space of 42,000 sq. ft.
and the
PLANT, MACHINERY AND EQUIPMENT
including
S.S. & S.C. CAPSTAN AND TURRET LATHES,
DRILLING, TAPPING, GRINDING, SHAPING, SLOTTING, PLANING, BORING AND OTHER MACHINES
PAINT SPRAY, HEAT TREATMENT AND SAND BLAST PLANTS
ACETYLENE AND ELECTRIC WELDING EQUIPMENT
AIR COMPRESSORS, ETC.
Further Particulars obtainable from:
Messrs. RICHARD ELLIS & SON, Chartered Surveyors, 165, Fenchurch Street, London, E.C.3. Tel.: Mincing Lane 4272
or
HENRY BUTCHER & CO., Industrial Auctioneers and Valuers, 73, Chancery Lane, London, W.C.2. Tel.: Holborn 8411.
E8434 L

FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1 ('Phone, SLOane 5259). E105 K

HIRE A £1500 CAMERA FOR ONLY £5. All other types of photographic equipment available.—B. Bennett and Sons, Ltd., 25/27, Oxford Street, London, W.1 (Telephone, GERard 9953). Catalogue on request. E128 K

MACHINERY Etc. WANTED

WANTED, Machines of all Types.
CASH PAID.
Norman E. Potts (B'ham), Ltd., 130, Moseley Road, Birmingham, 12. VIC. 1278, 1279, 1270, 0856.
E104 P

MODEL ULA.8 Vertical, 8-cylinder Mirrlees Diesel Engine, 269 h.p., 500 r.p.m.—BOX No. E8371, "The Engineer." F

FOR SALE

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary; cab control, 400/3/50.

40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary; cab control, 400/3/50.

40-ton Adamson, standard cab control, 42ft 3in. span 400/3/50.

20-ton Vaughan, standard cab control, 42ft. 3in. span, 6-ton auxiliary; 400/3/50. EIGHT AVAILABLE.

10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.

Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices about one-third of New.

FRED WATKINS (ENGINEERING)
LTD., COLEFORD, GLOS.
Tel.: Coleford 2271/2/3. E132 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel., Bexleyheath 305). E113 G

600

2500kW., 440/3/50, 4-wire PASS-OUT CONDENSING STEAM TURBO-ALTERNATOR SET, by B.T.H., steam pressure 255 p.s.i.g., 630 deg. F. temp. suitable for pass-out up to 55,000 lb./hr. between 18/35 p.s.i.g.; can operate fully condensing.

5000 c.f.m. TURBO-BLOWER, by Belliss and Morcom, 12 lb. air pressure, mounted on baseplate and direct coupled through gearbox to 400 h.p. synchronous motor by Lancashire Dynamo, 400/3/50, with control gear.

FOUR 800/875 c.f.m. Horizontal, Single-Stage Ingersoll Rand AIR COMPRESSORS, for 12/30 p.s.i., each motorised, 400/3/50, with control gear.

TWO 375kVA., 415/3/50, 4-wire Diesel-engine-driven ALTERNATOR SETS, mounted on baseplate and direct coupled at 750 r.p.m., incorporating a 468 h.p. Peter Brotherhood 8-cyl. engine driving alternators by G.E.C. with switchgear and standard ancillaries.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070: and
STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E205 G

FOR SALE

3-ton Taylor Jumbo Hydraulic Crane, diesel-driven.
1-ton Rapier Shop Truck Crane.
5-ton Coles diesel-driven self-propelled Mobile Crane on pneumatics.
5-ton Morris Versatile diesel/electric Mobile Crane on solid rubber tyres.
5-ton Smith Steam Loco. Crane 4ft. 8½in. gauge, 35ft. jib, new 1949.
6-ton Rapier Super petrol/electric Mobile Crane on solid rubber tyres.
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Fordson Major diesel Tractor, complete with Horndraulic shovel equipment.
¾ cu. yd. Rapier 410 diesel-driven Excavator with 4-purpose or dragline equipment.
¾ cu. yd. Rapier 423 diesel-driven Excavator with shovel or dragline equipment.
1 cu. yd. Rapier 440 diesel-driven Excavator with shovel or dragline equipment.

WILLIAM G. SEARCH, LIMITED,
WHITEHALL ROAD, LEEDS, 12.
Tel.: 639081 (10 lines).
SEARCH (LIVERPOOL), LIMITED,
HAMMOND ROAD,
KIRKBY TRADING ESTATE, LIVERPOOL.
Tel.: Simonswood 2634–5–6.
E7976 G

FOR SALE, One REFRACTORY LINED PRESSURE VESSEL, average dimensions 20ft. 4in. by 7ft. by ½in. thick, weight 6·75 tons approx.; and one TEMPERATURE REGENERATOR (comprising two refractory lined pressure vessels), offered as two separate units in their present site at the National Gas Turbine Establishment, Pyestock.—Can be viewed on application to Chief Contracts Officer, Ministry of Power, Thames House South, Millbank, London, S.W.1. E8424 G

FOR SALE

FRED WATKINS (ENGINEERING), LTD.

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Broomwade 400, 300, 200 and 130 cu. ft.; all motorised; Reavell Rotary Blowers, 2000 c.f.m., 3–2 p.s.i.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.

CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.–70ft. extendable jib; 6-ton and 4-ton Coles Diesel-Electric; 3-ton Jones Super 40 (3); Neals 2-ton Diesel, 20ft. jibs (2); Derrick, 5-ton Butters Electric travelling type, 90ft. jib; 5-ton Wilson Electric, 70ft. jib; Steam Loco, 18-ton Brownhoist, 50ft. jib; 10-ton Coles, 40ft. jib; 8-ton Wilson, 35ft. jib; 5-ton Smith, 30ft. jib; 5-ton Cowans Sheldon, 30ft. jib; 5-ton Grafton, 38ft. jib; E.O.T., 40-ton Adamson, 42ft. span; 20-ton Vaughan, 42ft. span (8); Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris; 5-ton Henderson, 24ft. 7½in. span, 1946; 5-ton King, 29ft. 3in. span; 2-ton Morris, 18ft. span, 2-ton Smith, 34ft. span.

LOCOS.—Fowler Diesel, 150 h.p. (2); Ruston Diesel, 80/88 h.p., new 1942; Hunslet 0–6–0, 18in. by 26in., new 1944; Bagnall 14in. by 22in., two oil fired, one coal; Peckett Steam, 7in. by 12in., 1941; Also 3 miles track, 24in. gauge Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new; 60,000ft., 3in. black new; 5000ft., 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 4000ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.

CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¼in.; Robertson Straightening Rolls, 8ft. 6in. by ¼in.; Berry Bending Rolls, 7ft. by ¼in.; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table; Herbert 3ND Miller, 61in. by 15in. table; Pels Punch and Shears, ¾in. capacity; nine new 2 cwt. and 1 cwt. Pneumatic Hammers.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E106 G

HYDRAULIC PRESSES

Unused 4000-ton HYDRAULIC HEAVY PLATE FORMING and BENDING PRESS, table 18ft. by 10ft., weight 380 tons.

2000-ton DOWN-STROKE HYDRAULIC FORGING PRESS, ram 31in. dia., admits 8ft. 7in. wide with horizontal sliding table, weight 200 tons.

1000-ton DOWN-STROKE PRESS by Loewy Eng., ram 27in. dia., bed 40in. by 48in.

650-ton DOUBLE-ACTION DRAWING PRESS by Lake Erie, bed 7ft. 6in. by 6ft. 8in., with self-contained pump unit.

MANY OTHER HYDRAULIC PRESSES OF ALL TYPES

REED BROTHERS (ENGINEERING), LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone: Woolwich 7611/6.
E8278 G

TWO NEARLY NEW POWERFUL CRANES

90-ton Electric Travelling Goliath Crane, 106ft. span, 72ft. lift, all lattice steel construction, electrics 400 volts, 3-phase, 50 cycles. Tested by Lloyds to 150 tons.

35-ton Electric Portal Wharf Crane, built 1945; 35 tons at 60ft. fixed radius, 85ft. height of lift, rail gauge 40ft., admitting 3 lines of standard gauge track, electrics 440/3/50, with Ward-Leonard generator.

REED BROTHERS (ENGINEERING), LTD.,
Replant Works, Woolwich Industrial Estate,
London, S.E.18.
Telephone: Woolwich 7611/6.
E8405 G

600

FOUR 400 h.p. ROLLING MILL SLIPRING MOTORS by E.E.C. wound for 415/3/50 738 r.p.m., coupled to Gearbox by Power Plant Co., final speed 30 r.p.m. High Speed shaft with two flywheels—total kinetic energy 10,000 h.p. seconds. 30 h.p. barring Motor and automatic Igranic control gear with slip-resistance.

750 h.p. ROLLING MILL MOTOR by Brown Boveri, date 1954; 2200/3/50, 146 r.p.m.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12
Tel.: Shepherds Bush 2070 and
STANNINGLEY, NR. LEEDS.
Tel.: Pudsey 2241. E219 G

MACHINE BELTING.—A quantity of Belting, square cut, edge canvas, various sizes, disposal due to alterations in drives.—Particulars on application, Gilbertson and Page, Ltd., Tamworth Road, Hertford, Herts. E2057 G

FOR SALE

TWW

TWO BRADLEY and TURTON FOUR-COLUMN, DOWNSTROKE HYDRAULIC PRESSES, capacity 350 tons at 2 tons p.s.i. working pressure, fescolised ram 15½in. dia., stroke 24in., daylight 37in., platens 37in. by 40½in., 4in. dia. push-back rams, 1½in. dia. ejector rams, prefill tank mounted on top of crosshead, and intensifier, input 1500 p.s.i.

ONE FAWCETT PRESTON FOUR-COLUMN, DOWNSTROKE HYDRAULIC PRESS, 200 tons capacity at a working pressure of 1500 lb p.s.i., fescolised main ram 20in. dia., stroke 24in., daylight 40in., platens 28in. front to back by 26in. left to right, distance between columns 26½in., push-back rams, ejector ram and prefilling tank.

ONE BRADLEY and TURTON DOWNSTROKE, FOUR COLUMN HYDRAULIC PRESS, 150 tons capacity at 1500 lb. p.s.i. working pressure, dia. of ram 17in., stroke 18in., daylight 29½in., platens 30in. by 28in., distance between columns 36in., fully guided top platen, push-back rams, ejector, and prefilling tank.

ONE SHAW FOUR-COLUMN, UPSTROKE HYDRAULIC PRESS, fescolised ram 19in. dia. at 1500 p.s.i. working pressure, stroke 17in., daylight 40in., platen size 30in. by 28in., distance between columns 36in.; the crosshead houses an 8in. dia. cylinder and ram, stroke of ram 15in., pull-back rams and prefilling tank.

THOS. W. WARD LTD.
ALBION WORKS - - - SHEFFIELD
'Phone: 26311. 'Grams: "Forward."
E215 G

SLOTTING MACHINE

ORMEROD 26in. Stroke SLOTTING MACHINE, table 50in. by 50in. with long., cross and rotary feeds, with rapid traverses in all directions, max. diameter admitted 7ft. 2in., max. height 3ft. 6in. Late type machine.

F. J. EDWARDS, LTD.,
359–361, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681 and 3771.
E8372 G

HYDRAULIC PRESSES
HYDRAULIC PUMPS

Hydraulic Accumulators, Valves, Fittings, New and Second-hand. Complete installations. All kinds of Hydraulic Equipment in stock.

THOMPSON AND SON (MILLWALL), LTD.,
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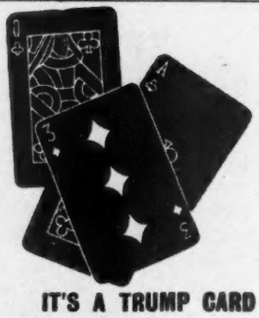
E111 G



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TWO BIGWOOD Type PBG 4-Roll Motorised Plate Bending and Straightening Machines ; three rollers set pyramid fashion for bending and additional fourth roller for flattening ; arranged motor drive 440/3/50, capacity 4ft. by ¼in., length of rolls 53½in. Weight approximately 90 cwt.

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SALES BY AUCTION

		Main Location	*Auctioneers*
Sept. 3	**Machine tools, Radar Trailers, and miscellaneous stores,** including spark plugs, etc.	Technical Stores Depot, Old Dalby, Melton Mowbray, Leicestershire. (Sale at Melton Mowbray.)	SHOULER & SON (Dept. L), 1, Norman Street, Melton Mowbray, Leicestershire. (Tel. : 81.)
Sept. 8–12	**Passenger and Load-carrying vehicles, earth moving and lifting equipment, motor cycles, etc.**	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel. : 47271.)
Sept. 9	**Miscellaneous stores,** including :—	General Stores Sub-Depot, Longtown, Near Carlisle. (Sale at County Hall, Carlisle.)	HARRISON & HETHERINGTON, LTD. (Dept. L), Bothergate, Carlisle. (Tel. : 26292.)

Large quantity of hand tools, 220 tons of various brass, copper and steel nuts, bolts, nails, screws and rivets, 90,000 yards of canvas, duck, sail, American cloth, etc., webbing, 80,000 fathoms of sisal, coir and manilla rope 2in. to 7in. circumference, greased packing materials, canvas roof covers, cardboard and corrugated boxes, tool chests, vacuum jars and liners, steel cooking containers, washing tubs, pie and cake tins, chairs, tentage, etc.

Sept. 16–17	**Miscellaneous stores,** including textiles, cordage, small tools, etc.	Central Ordnance Depot, Didcot, Berks.	SIMMONS & SONS (Dept. L), 12, Station Road, Reading, Berks. (Tel. : 54025.)
Sept. 19	**Miscellaneous stores**	Returned Stores Depot, Reed Hall, Colchester, Essex.	FENN, WRIGHT & CO. (Dept. L), 146, High Street, Colchester, Essex. (Tel. : 3171.)
Sept. 23	**Machine tools, plant and miscellaneous stores.**	M.O.S. Storage Depot, Harrogate Road, Yeadon, Leeds.	DACRE, SON & HARTLEY (Dept. L), Station Road, Otley, Yorks. (Tel. : 3321.)
Sept. 25–26	**Miscellaneous stores.**	M.O.S. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept. L), 20, King Street, Hereford. (Tel. : 4366.)
Sept. 30–Oct. 1	**Miscellaneous stores.**	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel. : 47271.)
Oct. 3	**Miscellaneous stores.**	Command Ordnance Depot, Coypool, Marsh Mills, Plymouth. (Sale at Kinterbury House.)	WOOLLAND, SON & MANICO (Dept. L), Kinterbury House, St. Andrews Cross, Plymouth (Tel. : 65356.)

Catalogues for the above auction sales, 1s. 0d. each (P.O.s only), available *only* from the auctioneers shown above.

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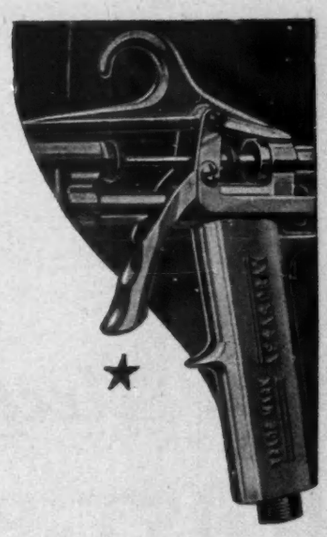

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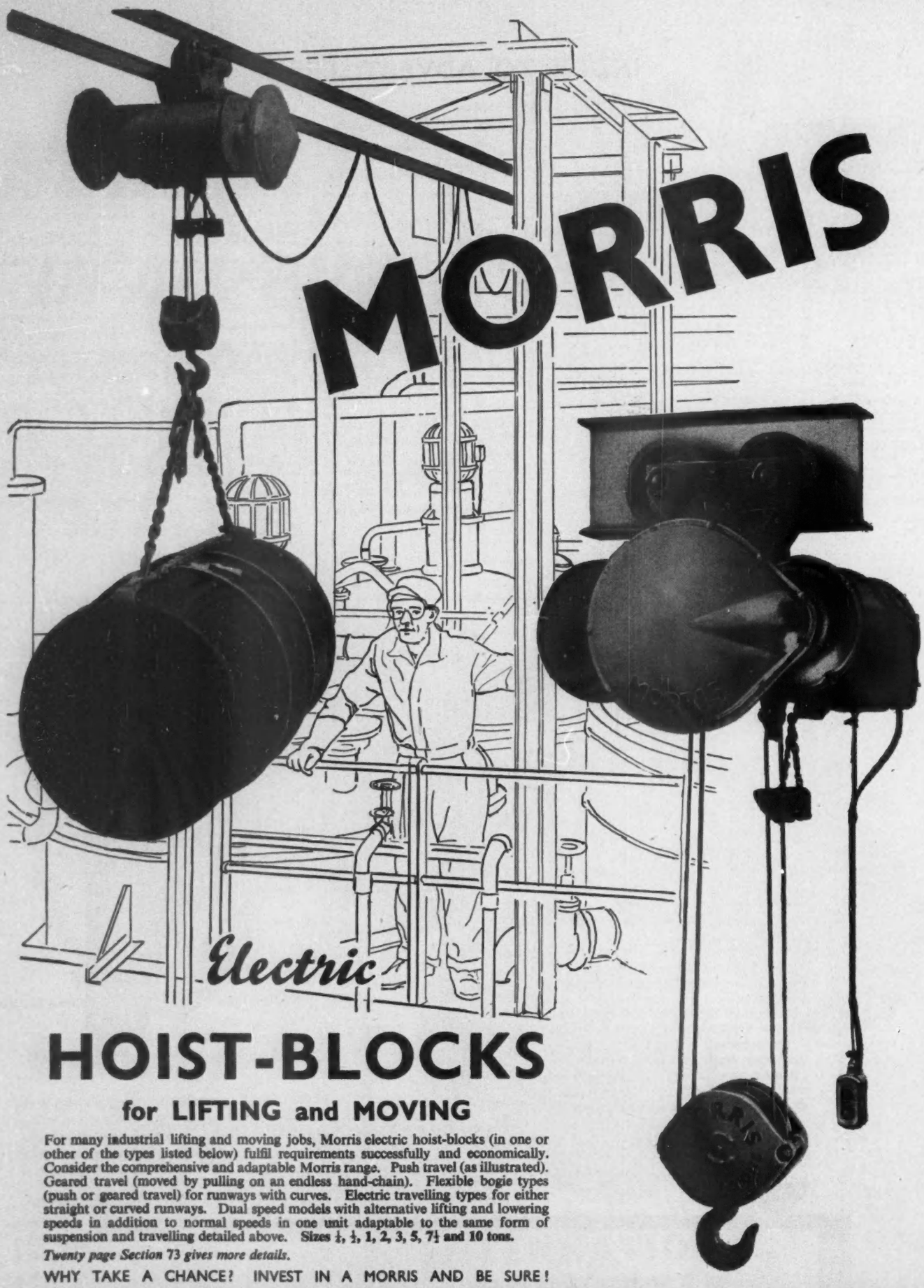

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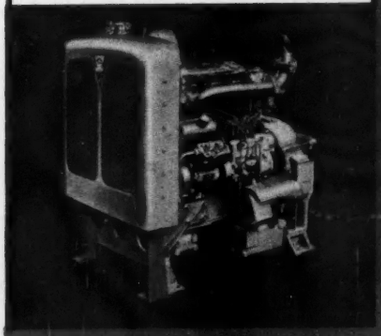
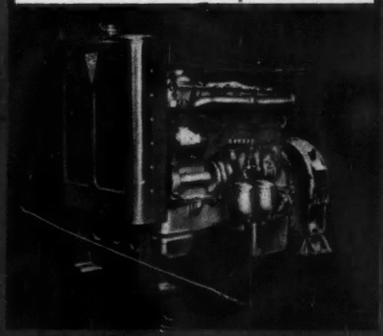
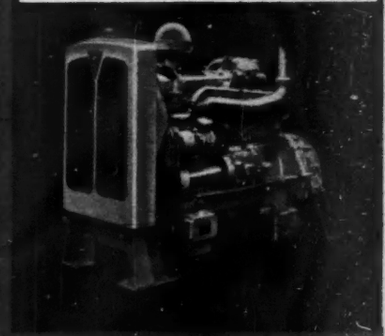


AV470G 6-cyl. diesel engine. **125**



A221K 6-cyl. diesel engine. **150**



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The Engineer

AUGUST 29, 1958

CONNECTED *Shaft* PROBLEMS

MOSS GEARED COUPLINGS are the perfect solution to the problem of retaining efficient operation of connected shafts. The spacer type coupling illustrated consists of two different sized couplings connected by a spacer tube thus enabling shafts of different diameters to be efficiently connected.

MOSS GEARS

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